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April 1939

UNITED STATES
DEPARTMENT OF THE INTERIOR
HAROLD L. ICKES, SECRETARY

BUREAU OF MINES
JOHN W. FINCH, DIRECTOR

INFORMATION CIRCULAR

TIN DEPOSITS OF THE BLACK HILLS, SOUTH DAKOTA

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UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

TIN DEPOSITS OF THE BLACK HILLS, SOUTH DAKOTA[1]

By E. D. Gardner[2]

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Supervising engineer, mining methods section, Mining Division, Bureau of Mines, Tucson, Ariz.

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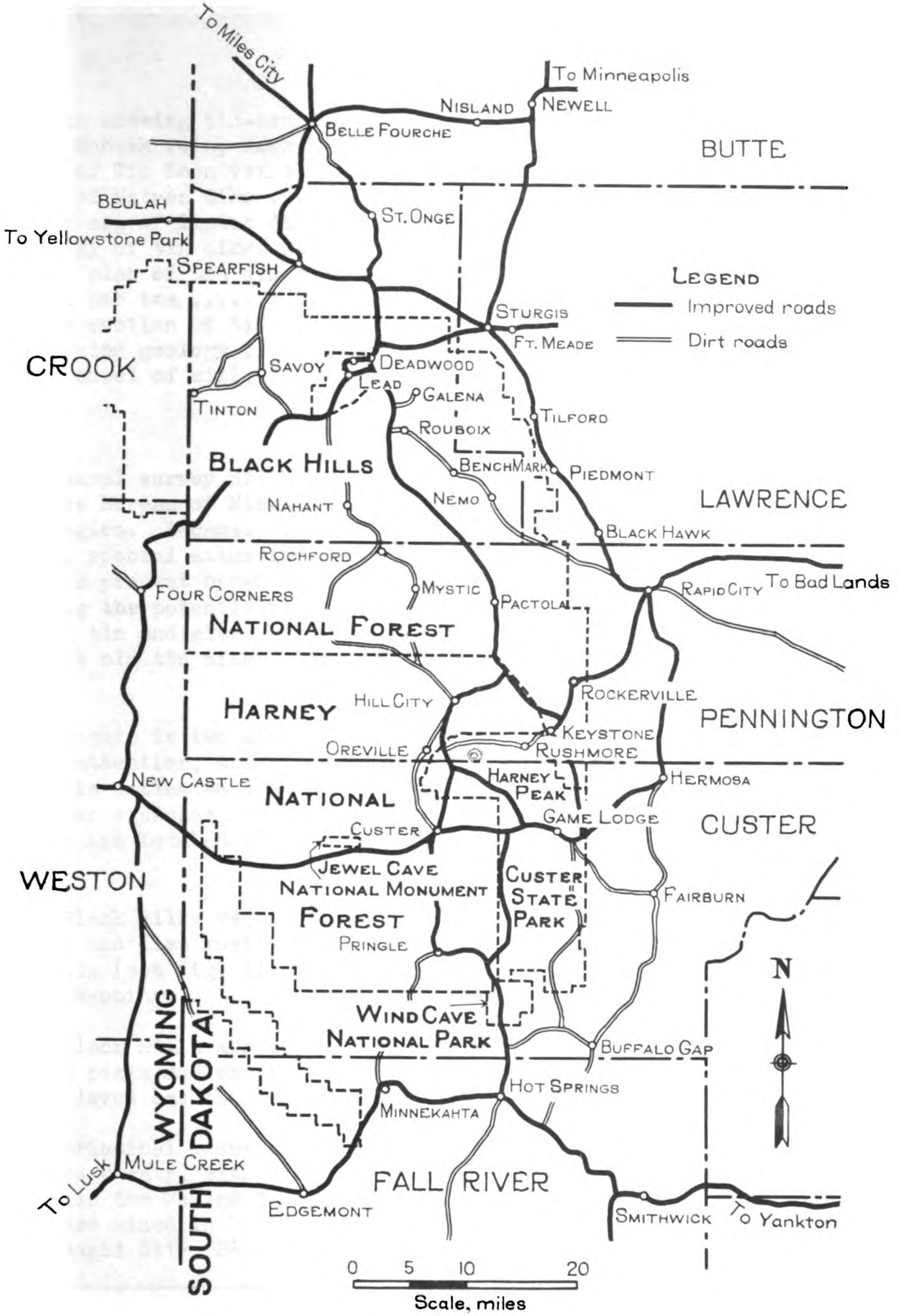

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INTRODUCTION

A general survey of the mineral industries of the Black Hills is being made by the Bureau of Mines, but this report is confined to the tin deposits of that region. Because of the strategic importance of tin in a national emergency, special attention was given in the field to deposits of this metal. The present paper outlines the procedure that would be required for determining the potentialities of the most promising deposits as emergency sources of tin and gives estimates of the cost of sampling and rehabilitating some of the old tin mines. Tin mining in the Black Hills was quiescent in 1938.

Tin occurs in two areas in the region. The deposits have received considerable attention, and since 1884 numerous articles have been written about them. It is estimated that between 7 and 15 million dollars has been spent in promotion expenses, acquiring claims, development work, and equipment; production has totaled about 160 long tons of metallic tin worth about $95,000.[3]

The Black Hills region is 60 to 75 miles long north and south and 50 miles wide and lies mostly in Lawrence, Pennington, and Custer Counties of South Dakota (see fig. 1); it extends a short distance into Weston and Crook Counties, Wyoming.

The Black Hills are an uplift that has been cut by erosion into mountain ridges and peaks and narrow valleys. Harney Peak, which rises 7,000 feet above sea level has the highest elevation.

The principal industry in the Hills is gold mining; the Homestake mine in Lawrence County, with a daily production of about $70,000, is the largest gold mine in the United States. Feldspar, Lithium, and other pegmatitic minerals are mined in Pennington and Custer Counties. There is a cement plant at Rapid City, Pennington County.

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[3] Cummings, J. B., and Lincoln, F. C., Tin Deposits in South Dakota: Published by State Planning Board, Brookings, S. Dak., as a W. P. A. Project, June 15, 1936, 35 pp.

The Black Hills also are important as a recreational area and are visited each year by thousands of tourists. The Hills are well timbered and watered, and lumbering is an important industry in the region. Farming and stock raising are carried on in many of the valleys. Paved highways built for the convenience of tourists run through the Hills, and the area is served by two railroads. Labor of a high type is plentiful.

Tin deposits occur in a relatively small area at Tinton in Lawrence County to the north and scattered over a larger area around Harney Peak in Pennington and Custer Counties to the south.

The Black Hills are locally divided into the Southern and Northern Hills, and the tin areas are similarly designated.

The field work on which this report is based was done in July and August 1938.

ACKNOWLEDGMENTS

Mining operators, claim owners, the Chamber of Commerce at Rapid City, and the Chamber of Commerce at Spearfish cooperated fully with the Bureau of Mines in making the mineral survey of the Black Hills.

Dr. Francis C. Lincoln, of the Idaho School of Mines, was especially helpful in starting the work. The assistance of Arthur I. Johnson, of Keystone, is particularly acknowledged, and Joseph R. Guiteras, mining engineer, Bureau of Mines, helped in the field and accompanied the writer on all examinations. Credit to others who assisted in various phases of the work is given later in the text.

The chapter on history is abstracted from Tin Deposits in South Dakota.[4] Table 2, showing the production of tin in the Black Hills and the bibliography at the end of this paper are also from this work.

PRODUCTION

The production, imports, consumption, and price of tin in the United States, from 1918 to 1938, inclusive, are shown in table 1. These data are taken from Mineral Resources and Minerals Yearbook; the quotations for tin in 1938 are taken from the Engineering and Mining Journal.

During 1937 the total production of tin in the United States was 144.8 long tons,[5] valued at $176,000, an all-time high; of this quantity, 142.4 tons was produced in Alaska as a byproduct of gold dredging. The remaining 2.4 tons was produced from placer mining in Mallory Gulch in the Black Hills; 0.8 ton came from South Dakota and 1.6 tons from across the line in Wyoming. The Black Hills production was still more valuable on account of its tantalum content.

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[4] Cummings, J. B., and Lincoln, F. C., work cited in footnote 3.

[5] Miller, R. B., Tin: Bureau of Mines Minerals Yearbook, 1938, p. 613.

TABLE 1. - Production, imports, consumption, and price of tin in the United States, 1918 - 1938.

Year	Primary tin (long tons)			Exports (long tons)	Price, cents per pound
	Domestic production	Imports			
		From concentrates	Metallic tin		
1918	62	9,088	63,620	254	86.80
1919	50	10,875	40,044	341	65.54
1920	20	15,743	56,067	927	50.36
1921	4	10,301	24,197	1,393	30.00
1922	1	8,131	60,193	1,098	32.58
1923	2	6,664	68,934	1,046	42.71
1924	7	155	65,059	959	50.20
1925	12	191	76,646	932	57.90
1926	7	303	77,159	1,980	65.30
927	24	122	71,142	2,239	64.37
928	42	130	77,970	1,617	50.46
929	35	128	87,127	1,930	45.19
930	15	239	80,734	2,233	31.70
931	4	30	66,064	1,661	24.46
932	0	17	34,819	1,116	22.01
933	3	24	63,718	1,041	39.12
934	8	2	39,986	1,216	52.16
935	44	178	64,258	2,292	50.39
936	101	179	76,029	386	46.42
937	144	151	88,115	313	54.24
938					[1] 41.52
Total.	585	62,701	1,281,881	24,974	

/ Average for first 10 months in 1938. Highest monthly average, May 1918, 105 cents; highest quotation, 1918, 110 cents; lowest quotation, 1896, 12-5/8 cents.

Imports of tin for consumption in the United States for 1936 and 1937 re as follows:

	Long tons	Value
1936	76,029	$75,450,941
1937	88,115	104,284,762

Tin production in the Black Hills, 1884 to 1936, is shown in table 2.[6]

The references in table 2 are given in the bibliography which contains arly all publications pertaining to tin in the Black Hills.

Cummings, J. B., and Lincoln, F. C., Tin Deposits in South Dakota: Published by State Planning Board, Brookings, S. Dak., as a W. P. A. Project, June 15, 1936, p. 4.

Original from THE OHIO STATE UNIVERSITY

TABLE 2. - Tin production of the Black Hills, 1884-1936

Year	Source	Short tons	Character	Tin, percent	Tin, pounds	Value[1]	References
1884	Bear Creek and Sand Creek[2]	5-6	Stream tin	3/50.0	5,500	$1,210	4
	Etta mine	(4/)	Metallic	-------	-------	-------	4
1885	No production	-----	-------------	-------	-------	-------	3
1886	Etta mine	400.0	Ore	.5	14,000	3,059	3
	Bear Creek	6.5	do.	4.6	598	129	26
1887	American & Cleveland Tin Mining Co.	3.0	Stream tin	50.0	3,000	887	
	H. W. Fowler Tin Mt. mine	(4/)	Ore	-------	-------	-------	-----
			Metallic	-------	250	74	1
			Concentrates	-------	-------	-------	-----
1888	Harney Peak Tin Mining, Milling & Manufacturing Co.	50.0	Ore	2.5	2,500	500	23
1889-91	No production	-----	-------------	-------	-------	-------	28,3
1892	Harney Peak Tin Mining, Milling & Manufacturing Co.	150.0	Concentrates[3]	60.0	180,000	37,800	35
1893	do.	(5/)	do.				40
1894-1900	No production	-----	-------------	-------	-------	-------	42-48
1901	Oreville	.6	Concentrates	50.0	817	212	51
1902	No production	-----	-------------	-------	-------	-------	52
1903	Tinton Tin Mining Co.	40.0	Concentrates	62.5	50,000	14,000	55
1904	do.	(5/)	do.	-------	-------	-------	60
1905	No production	-----	-------------	-------	-------	-------	63
1906	Gertie Tin mine	1.8	Concentrates	66.5	2,500	1,050	65
1907	do.	(4/)	Metal	-------	-------	-------	---
	Frank Hebert, Oreville	(4/)	Concentrates	-------	-------	-------	---
	Bear Gulch & Gold Hill Mining Co.	(4/)	do.	-------	-------	-------	66
	Western Chemical Reduction Co.	(4/)	do.	-------	-------	-------	---
1908	No production	-----	-------------	-------	-------	-------	69
1909	Tinton Reduction Co.	24.0	Concentrates	34.0	16,714	4,832	73
1910	do.	38.0	do.	50.0	38,000	12,600	75
1911	Bear Creek, Tinton	(5/)	Stream tin	-------	-------	-------	77
1912	No production	-----	-------------	-------	-------	-------	82
1913	J. L. White, Tinton	1.0	Stream tin	75.0	1,500	660	84
1914	Bear Creek, Tinton	(6/)	do.	-------	-------	-------	87

1/ Based on market prices of metallic tin for year.

2/ Bear Creek is in the Tinton district, and Sand Creek is just across the line Wyoming.

3/ A part smelted. Numbers underlined are estimated.

4/ Several hundredweight.

5/ Small quantity.

6/ Few hundredweight.

TABLE 2. - Tin production of the Black Hills, 1884-1936 - Continued

ear	Source	Short tons	Character	Tin, percent	Tin, pounds	Value	References
915	Hill City Tungsten Producers Co.	43.0	Ore	1.5-2	1,505	$ 602	--------
	J. L. White	.25	Stream tin	60.0	300	120	87
916	Hill City Tungsten Producers Co.	-----	--------------	-------	-------	(7/)	--------
	J. L. White	.2	Stream tin	60.0	240	108	91
17	American Tin & Tungsten Co.	22.0	Concentrates	26-65	22,000	8,200	
	J. L. White	.1	Stream tin	60.0	196	75	94
18	Tin Boom mine	.2	Concentrates	60.0	240	200	101
19	No production	-----	--------------	-------	-------	------	98
20	National Tin Corporation	12.0	Concentrates	50.0	12,000	6,000	103,112, 113,115, 117,120, 123
26	No production	-----	--------------	-------	-------	------	
27	Black Hills Tin Co., Tinton	1.0	Concentrates	65.0	325	200	124
28	Tinton and Harney Peak areas	-----	Stream tin		4,000	2,000	125
29	do.	-----	do.		500	200	127
30	do.	.5	Concentrates	31.5	315	100	128
31	do.	-----	Stream tin		189	50	130
32	do.	-----	do.		1,000	220	131
33	do.	-----	do.		225	88	132, p. 445
4	Tinton area	-----	do.		448	234	132, p. 504
5	A. J. Johnston, Tinton	-----	do.	65-72	1,300	260	------
6	do.	-----	do.	65	300	60	------

recorded production of tin concentrates worth $14,000 proved to be tantalum
ncentrates.

HISTORY

Cassiterite (tin oxide)[7] was identified in gold dust from the Northern Hills
76 and discovered in placer mines in the Southern Hills in 1877; these dis-
ies, however, caused only passing interest. The mineral was found in situ
Etta mine in the Southern Hills in 1883. Following this discovery the Hills
xtensively prospected for tin. Tin was found soon afterward at Tinton in the
rn Hills and scattered over a larger area around Harney Peak in the Southern
the peak is between Hill City and Custer. A tin boom was in progress from
o 1893. The history of tin mining in the Black Hills has been divided into
eriods.

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mings, J. B., and Lincoln, F. C., work cited in footnote 6.

First Mining Period

The first period extended from 1884 to 1893, inclusive, during the tin boom. The boom, however, occurred mostly in the Southern Hills, as there was little production around Tinton. Numerous tin companies were formed, the largest of which was the Harney Peak Tin Mining, Milling & Manufacturing Co., which was financed in England. This company was capitalized at $10,000,000 and pursued a policy of expansion; it eventually gained control of hundreds of claims, including most of the tin-bearing ground in the Southern Hills.

In 1885 a 100-ton mill was built at the Etta mine; in 1886 about 400 tons of 1/2-percent ore was treated. In June 1888 the capital stock was increased to $15,000,000; 50 tons of ore, mostly float, including one boulder from the Tenderfoot weighing 2,200 pounds, was shipped to England and exhibited at the World's Fair in Paris in 1889 to assist in the stock-selling campaign being conducted. In 1889 a new concentrator with a daily capacity of 250 tons was begun at Hill City. It was completed in 1894 at a cost of $240,000, however, it never treated over 50 tons of ore in one day. In 1892, 150 tons of concentrate was produced at the Etta mill. In 1894, 5,000 tons of ore was treated at the Hill City mill. The holdings of the company were examined during the year by Capt. Josiah Thomas of the Dolcoath mine, Cornwall, England, who reported that the company owned 1,100 claims extending in a semicircle for 30 miles about three-fourths of the way around Harney Peak. He held that most of this ground had little or no value but considered that the Cowboy, Gertie, and White Whale claims showed promise. He also stated that ore was blocked out in the Addie, Cowboy, Coats, Gertie, and Tenderfoot claims. The company went into the hands of a receiver in 1[illegible]- and ceased production.

The only other producer during this period was the Tin Mountain mine operated by H. W. Fowler in Warren Gulch. The mine was equipped with a 50-ton mill; a small quantity of concentrate was produced in 1887.

The production from the Northern Hills during this period was mainly stream tin. In 1884, 5 or 6 tons of stream tin was taken from Baer Gulch and Sand Creek. In 1887, 3 tons was produced from Nigger Hill. In 1886, 6 1/2 tons of ore containing 4 1/2 percent tin was produced on the James Callahan property and shipped to England. Several tons of ore was also produced in 1887. About 205,000 pounds of metallic tin valued at about $43,000 was produced in both areas during this period; of this quantity, about 3 tons was produced in the Northern Hills.

Second Mining Period

The second mining period extended from 1894 to 1911. The only production during this period in the Southern Hills came from the Gertie mine; a small quantity of concentrate was produced in 1901 and a somewhat larger quantity in 1906 and 1907.

Tin mining became active at Tinton in the Northern Hills in 1902. The Tinton Tin Co. did consistent development work in 1902 and 1903 and built a small concentrating plant from which 40 tons of concentrate was shipped to England. The ore treated contained 1 percent metallic tin and the concentrate 62 1/2 percent tin. A small quantity of concentrate was produced in 1904. In 1908 the Tinton mill was remodeled by the Tinton Reduction Co., which in 1909 produced 24 tons of concentrate. Further changes were made in 1910, and 38 tons of concentrate containing 19 tons of metallic tin was produced. Operations were discontinued at the property in 1911. A total of 108,000 pounds of metallic tin worth about $32,000 was produced from both areas during the second period.

Third Mining Period

The third mining period was from 1911 to 1920. The main production came from the Southern Hills near Hill City. The output from the Tinton area consisted of stream tin from Bear and Potato Creeks and never amounted to more than a few hundred pounds each year. In 1915 the Hill City Tungsten Producers Co. mined 43 tons of ore which carried 1 1/2 to 2 percent tin from the Jolly and Mohawk claims; the ore was milled in the McNish and Mills plant near Hill City. This company ceased operations in 1916 after it had milled 1,000 tons of tantalum ore under the impression that it was tin; it was succeeded by the American Tin & Tungsten Co. In 1916 the new company operated the Cowboy mine and milled its ore in a plant in the old building of the Harney Peak company. Twenty-two tons of concentrate valued at $8,300 was produced before the mill ceased operations in April of that year. Development work continued at the Cowboy and Mohawk mines in 1917 and 1918; 2,500 tons of ore claimed to average 2 percent tin was said to have been mined from the Cowboy claim in 1918 but not sold. The capacity of the mill was then reduced to 100 tons per day. Four hundred pounds of concentrate was produced by the Mills Bros. during assessment work on the Tin Boom claim belonging to the American Tin & Tungsten Co. in 1918. In 1919 the American Tin Corporation succeeded the American Tin & Tungsten Co.; work was continued on the Cowboy, Mohawk, and Tin Boom claims until 1920 when 800 tons of ore yielded 12 tons f concentrate with a value of $6,000. Operations ceased in September of hat year. No more tin was produced in the Black Hills until 1927. During he third period about 30,000 pounds of tin valued at about $16,000 was roduced.

Fourth Mining Period

The fourth mining period began in 1927, after 7 years of inactivity from 920 to 1926, inclusive, and has continued to the present. Since 1927 there as been a small, regular production of stream tin as a byproduct of gold lacer mining in the Tinton district. In 1926 the Black Hills Tin Co. took ver the property of the Tinton Reduction Co. and remodeled the Tinton mill. small quantity of concentrates was produced in 1927 and 1928, but this ndertaking, like its predecessors, did not prove successful.

In 1938 the Fansteel Corporation leased part of the company holdings nd was mining and milling daily about 30 tons of ore containing tantalum. art of the tin mill was remodeled to handle the ore. A small byproduct of in was being made. The Black Hills Tin Co. was developing a gold lode near he tantalum mine.

In the summer of 1938 the Dakota Tin & Gold Co. was sinking a shaft to develop a dike on what is known as the John White property near Tinton.

There was no tin-mining activity of any kind in the Southern Hills in 1938. About 500 pounds of cassiterite, however, was saved as a byproduct at the Peerless feldspar mine at Keystone. Many of the patented tin claims, including the Cowboy and Mohawk, had been taken over by Pennington County for the nonpayment of taxes.

From 1927 to 1936, inclusive, stream tin containing 8,602 pounds of tin worth $3,412 was produced in the Black Hills.

SOUTHERN HILLS DEPOSITS

Tin is found in the Southern Hills in pegmatite dikes scattered through six townships; most of them, however, are within 10 miles of Hill City. (See fig. 2.)

The principal tin-bearing dikes were examined; these included those that had been worked and others reported to be a possible source of tin. Hundreds of other dikes occur in the region; doubtless an appreciable number of these dikes contain some tin, but it is believed that no important ones were missed. The writer was accompanied either by George W. Coats or H. G. Mills, both of Hill City, in making the examinations. Coats is familiar with tin mining in the Southern Hills and has been in the Hill City district since the early days. As a boy he made some of the first discoveries of tin in the region. Mills has been interested in tin mining and has spent most of his life in the area. Other old-timers were consulted, and claims reported by them to be of any importance were visited.

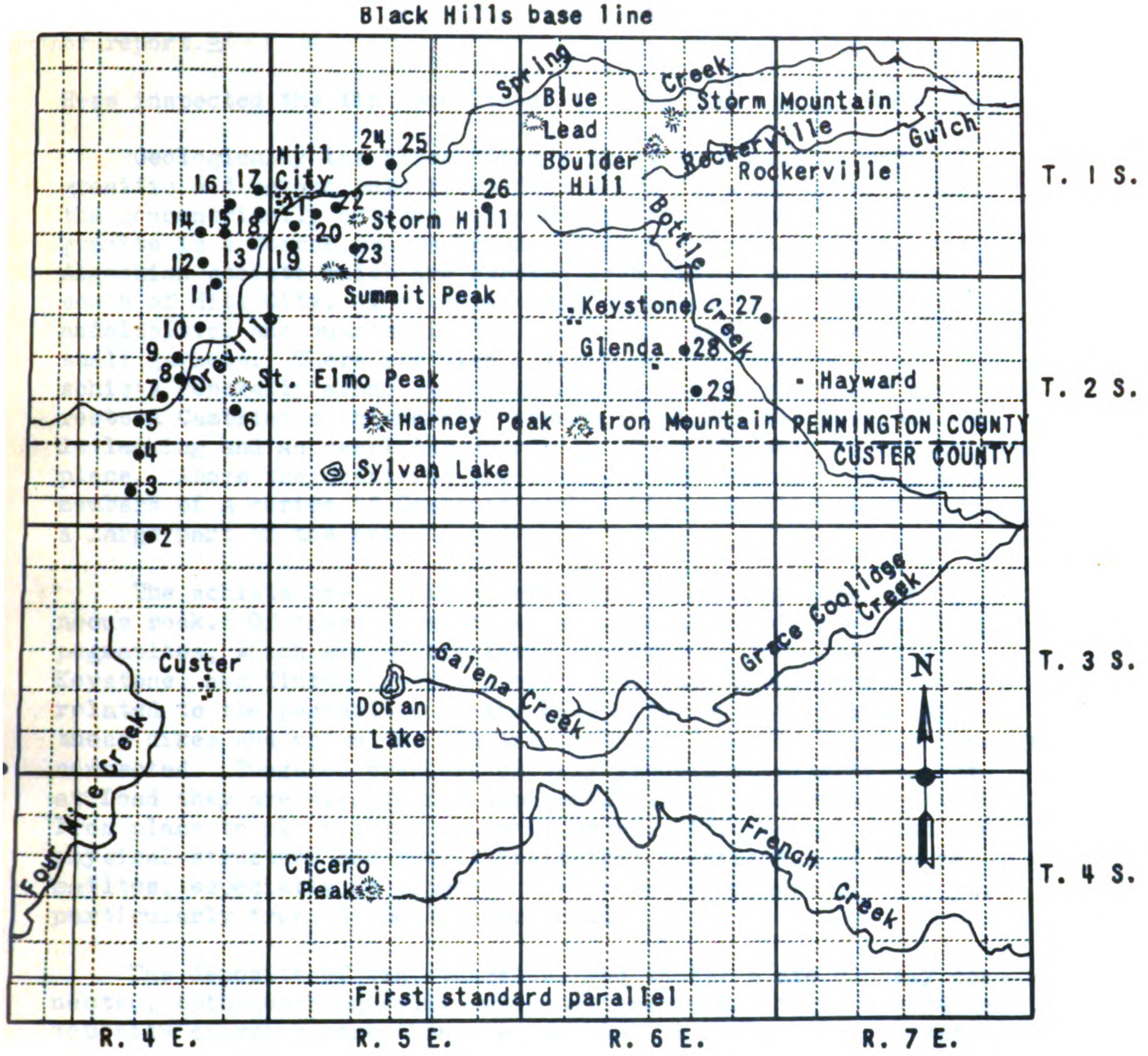
The development work on most of the claims was done in the nineties; most of the workings were caved so that examinations had to be confined to the surface. Most of the descriptions of conditions underground are taken from written accounts or from hearsay.

Geology

Two types of pegmatite bodies are found in the Southern Hills - narrow dikes, and wide dikes which may change in form into laccoliths.

The wide dikes contain relatively large segregations of feldspar and other valuable nonmetallic minerals. They have been worked for the nonmetallic constituents, and tin production has been incidental and insignificant. The Etta deposit, however, was first exploited for tin.

The narrow dikes, rarely over 6 feet wide, have been the principal producers of tin. Some of the dikes consist of pegmatite and others of greisen (quartz and mica). Although the principal production has come from the greisen dikes (also called quartz veins) the two types appear to be of about equal importance. Some dikes are as much as 550 feet long, but most



1 - Tin Mountain
2 - Old Jeff
3 - Tenderfoot group
4 - Louise
5 - Deacon Wright
6 - Tin Queen
7 - Naiad Queen
8 - Tin City
9 - Sally Cavenaugh

10 - Tin Plate
11 - Olympia
12 - Blue Bird
13 - Gertie
14 - Coats
15 - Cowboy
16 - Campaign
17 - Tin Boom
18 - Mohawk
19 - White Whale

20 - Mewonitoc
21 - Jackson and Top Sheaf
22 - Custer
23 - Addie
24 - Carnbray
25 - Snowshoe and Tin Belle
26 - Hopeful
27 - Etta
28 - Tin Hall
29 - Glendale

Figure 2.- Most important tin deposits in Southern Blacks, South Dakota. (After Cummings.)

of them are less than 200 feet. The wide dikes will be described in another report.[8]

Hess inspected the tin deposits of the Black Hills in 1908. He states:[9]

> Geologically the Black Hills consist of a central mass of granitic and metamorphic rocks from which dip away on all sides the concentrically outcropping younger rocks of the plains. The granite is a coarse pre-Cambrian pegnatitic intrusive cutting the Algonkian schists which are exposed from Tinton to the region south of Hill City. The schists are amphibolitic, staurolitic, andalusitic, and quartzitic, in places containing a great many small garnets. There are also interbedded quartzites. The schists generally stand at a high angle, and on their eroded edges rests a Cambrian conglomerate, though in places the conglomerate is lacking and an overlying quartzite 10 to 25 feet thick takes its place. Above the quartzite are dolomite and shales. These are members of a series of Cambrian rocks which have been eroded from a large part of the area.
>
> The schists are cut by numerous dikes of many kinds of igneous rock. Of these dikes this paper is most concerned with the pegmatites, which are particularly numerous in the Hill City, Keystone, and Tinton areas. A series of quartz veins are closely related to the pegmatites in the Hill City-Keystone area. With these dikes and veins the tin and tantalum deposits are inseparably connected. Tungsten ores are closely associated with them, but at Lead they are also found, apparently with other relations. From place to place there is considerable difference in both the physical structure and the mineralogical composition of the pegmatites, especially as concerns the accessory minerals. This is particularly true in the Southern Hills.
>
> The deposits of tin, tungsten, and tantalum are closely connected, both geographically and genetically, and though workable deposits carrying more than one of these minerals have not yet been proved, this is not out of the range of possibility.

The schist country rock is locally called slate from its slaty appearance. ll of the narrow dikes or veins are of the same general character. They nsist either of quartz, feldspar, and mica or of quartz and mica.

The tin mineral is cassiterite; its color ranges from dark brown to ack, and it has a light chocolate-color streak when scratched. The quartz d feldspar of the pegmatite are white except at places on the surface ere they are slightly iron-stained. The black tin mineral is easily seen

---

Guiteras, J. R., Mining of Feldspars and Associated Minerals in the Black Hills of South Dakota: (Now in preparation.)

Hess, F. L., Tin, Tungsten, and Tantalum Deposits of South Dakota: Geol. Survey Bull. 380, 1909, p. 132.

in the pegmatite; usually it occurs as definite grains or crystals 1/32 to 1/4 inch in diameter. Bunches of massive cassiterite as much as 6 inches thick have been found. Single crystals up to 1 inch in diameter were noted; at a few places the cassiterite is finely divided (generally in feldspar) into small specks locally called "pepper tin." Tantalite and columbite may be mistaken for cassiterite, and occasionally a glass is required to distinguish cassiterite from small tourmaline crystals.

The cassiterite is found in the veins as isolated crystals or in isolated groups of crystals interspersed with barren material. In a few places the mineral is segregated in irregular seams and bunches in the pegmatite, forming ore shoots. The largest shoot found is the Cowboy which is 70 feet long and 2 feet wide; apparently it extends to the 200-foot and possibly to the 300-foot level. Generally, however, the cassiterite is too widely scattered to form ore shoots; to obtain the tin, long stretches of barren material must be broken.

The black crystals in a white gangue, the relatively large size of the individual particles, and the tendency of particles to bunch make it possible to detect tin by eye in dikes that may assay less than a pound of tin to the ton over mining widths. Thus, casual inspection of a dike may give the impression that the rock contains more than the percentage of tin actually contained.

Sampling Methods

Some of the discussions of individual properties later in this report include estimates of the cost of further exploratory work required to determine their value as potential sources of tin. As this value depends primarily upon the extent or volume of the deposits and the percentage of tin or grade of the ore, a sampling procedure that will give truly representative samples for assay is of utmost importance.

The irregular occurrence of cassiterite in the Black Hills tin veins makes it difficult to sample the deposits; relatively large samples should be taken at close intervals to assure accuracy.

As there is some question as to the accuracy of the methods used for assaying tin when the percentage of tin is low in the samples, some engineers prefer breaking large samples, concentrating the tin mechanically, then havin the concentrates assayed. In any event, where the results of the sampling are important, large samples should be taken; where practicable the samples sho run at least 100 pounds to the linear foot.

Vein outcrops

The outcrops of the tin dikes generally are irregular in profile and are difficult to sample systematically. The method of taking the sample usually must be adapted to the conditions at each particular occurrence. An outcrop may be sampled by cutting standard grooves either by hand or by air machines, or if mill tests are to be made the top layer or definite sections may be broken by drilling and blasting. The difficulty of preventing loss of flying particles due to blasting usually makes it impracticable to take channel samples by drilling and blasting at the surface.

Samples should be taken across narrow tin veins at intervals of 5 feet or less. When cut by hand, grooves generally are 1/2 to 1 inch deep and 6 inches wide; if cut with drilling machines, they may be as much as 2 inches deep and 12 inches wide. The degree of accuracy is increased by cutting larger grooves. With 1-foot grooves at 5-foot intervals, 20 percent of the surface of a vein outcrop would be included in the sample and with 6-inch grooves, 10 percent.

In wide veins the sampling interval may be increased. Grooves may be cut or trenches may be run across the outcrop at intervals and the material from each definite section used for the samples. Where mill tests are to be made near the mine the entire sample may be used for the purpose. Generally, however, the samples are quartered by hand at the mine to about 100 pounds; large fragments are broken with hammers before quartering.

Narrow Veins Underground

As on the surface, samples in narrow veins should be cut across the trike at fairly close intervals. Usually it is easier to cut the samples t the top than at the bottom of a drift. As the space is confined the cuts an be made by drilling and blasting when large samples are desired. The ame procedure is followed in shafts; the samples are cut across the vein at efinite intervals.

Wide Veins Underground

In wide tin dikes, samples are taken along one or both the sides, or long the top of crosscuts. A continuous cut should be taken; separate amples usually represent 10-foot sections. Samples in drifts in wide veins re taken across the full width of the drifts; the interval generally is 5 eet. Samples in shafts in wide deposits generally are taken across the trike at definite intervals.

The manner of sampling wide deposits depends to some extent upon the mber of samples to be taken and the mining and milling equipment available. enough samples are to be taken it may prove economical to install air nes and cut the samples with air machines instead of by hand. Portable r compressors large enough to run two drills generally can be rented for out $75 per month.

The samples should be taken by moiling off about 100 pounds per linear ot in a channel or by drilling and blasting a series of short inclined holes ong the sample lines. The latter method would be the most economical and uld give a larger sample, but the channel made would be more irregular in oss section than if the sample were taken by moiling.

Cost of Sampling

Vein Outcrops. - One man with a moil probably could cut 10 to 12 linear feet of groove 1 inch deep by 6 inches wide (about 7 pounds per linear foot) in an average tin-bearing dike in the Black Hills during an 8-hour shift. A groove of the same length 2 inches deep by 12 inches wide (about 28 pounds per linear foot) probably could be cut in the same time by a man using a jackhammer. He could clean up the face sampled and sack the samples during the shift but could not do much digging to reach the vein.

The estimated cost per sample across a 3-foot vein at the surface would be:

Labor cutting (3 samples per day) at $5 per shift	$1.67
Supervision, 1 engineer at $10 per day to 2 samplers ..	1.67
Tools and sharpening moils	.66
Sacking and transportation of samples	.50
Assaying	2.00
Total	6.50

The cost of cutting the sample would increase proportionally with the width of the vein up to 10 feet; with wider veins two or more samples probably would be taken at each interval.

The cost per sample across a 5-foot vein would be:

Labor cutting (2 samples per day) at $5 per shift	$2.50
Supervision	2.50
Tools and sharpening moils	.75
Sacking and transportation of samples	.50
Assaying	2.00
Total	8.25

The estimated cost per sample when drilling by hand, breaking a 1-foot layer 10 feet long from the top of the outcrop and 3 to 5 feet wide (even with the surface of the ground or bottom of the trench), and concentrating the cassiterite before assaying would be:

Labor, 2 shifts	$10.00
Explosive	.50
Tools and sharpening steel	3.00
Supervising (2 crews)	5.00
Quartering 4-ton sample, 1 shift	5.00
Sacking and transportation of sample, 1 ton	2.00
Crushing, grinding, and concentrating samples, 1 shift.	5.00
Assaying (concentrate and tailing)	4.00
Total	34.50

This figure corresponds to a cost per sample of $16.50 (two 5-foot intervals) by the groove method on a vein 3 feet wide.

The estimated cost per sample when drilling by hand and blasting a row f holes (to break 1 foot deep) across a 4- to 6-foot vein would be as ollows:

Labor (2 samples per day)	$2.50
Explosive	.25
Tools and sharpening drills	1.50
Supervision	2.50
Sacking and transporting sample (400 pounds)	1.00
Crushing, grinding, and concentrating sample, 1 shift	5.00
Assaying (concentrate and tails)	4.00
Total	16.75

For two samples corresponding to a 10-foot section the cost would be 33.50. A mat made of timbers wired together would have to be laid over ots before blasting to prevent loss of part of the sample.

Narrow Veins Underground. - Cutting grooves in drifts driven from adits uld cost about the same as on the surface, and blasting cuts from the side back of the drift would cost about the same or a little less than on top.

Where the drift is driven from a shaft the wages of a hoisting engineer d power and pumping costs of about $7.50 per day would have to be added. four samples were taken daily the cost would be about $2 extra for each mple.

The labor of cutting a sample by hand across the face of a narrow vein a shaft would cost about the same as in a drift; the cost of putting up staging at each sampling point would be about the same as that of cutting 3-foot sample. The total would be about $13 per sample in a 3-foot vein d $15 in a 5-foot vein.

Wide Veins Underground. - The cost per foot of sample of cutting groove ples by hand would be about the same in wide veins underground as in row veins.

The cost of sampling wide dikes by drilling and blasting channels is ustrated by the estimates for sampling the Rough & Ready deposit given pages 56, 57, and 58 of this report.

Mines and Prospects

Most of the Southern Hills properties described herein once belonged to Harney Peak Tin Mining, Milling & Manufacturing Co. Extensive develop- t work was done by this company on a large number of claims. According to d,10/ the amount expended for this purpose was $7,500,000.

Bland, John, Tin and Tungsten in South Dakota: Min. and Sci. Press, vol. 114, Mar. 31, 1917, pp. 441-444.

Cowboy

The Cowboy mine, which has been the largest producer of tin in the Hill City region, is about 1 mile westerly from Hill City; the Cowboy claim, which contains the tin-bearing dike, is one of a group of three patented claims.

Two boys, George W. Coats and A. L. Palmer discovered the Cowboy deposit while driving home their families' cows; it was located by their fathers on June 10, 1884 and named in their honor.

The Cowboy was a part of the holdings of the Harney Peak Tin Mining, Milling & Manufacturing Co.; this company sank the main shaft and did most of the lateral development work.

According to Mineral Resources, 1916-20, the Hill City Tungsten Producers Co. obtained the Cowboy mine early in 1916, reequipped the old Harney Peak company mill, and began mining, but the production of tin was very small. Its successor in title, the American Tin & Tungsten Co., operated the mine about 3 months in 1917; work was stopped in April as a result of a lien on the property by the employees. The National Tin Corporation operated the Cowboy the first 8 months of 1920, and in February 1937 it was acquired by Pennington County on a tax lien. No work has been done on the property since 1920.

Production. - The authors of Tin Deposits in North Dakota estimate that about 4,000 tons of ore has been mined from the Cowboy mine.

Knopf reports that a few tons of concentrate was shipped in 1916 from South Dakota and North Carolina.[11] The South Dakota production was made by the Hill City Tungsten Producers Co., presumably from the Cowboy mine. In 1917,[12] 23 tons of concentrate carrying 50 percent tin was shipped by the American Tin & Tungsten Co. from the Cowboy to Perth Amboy, N. J.

Knopf[13] states that according to the management of the American Tin & Tungsten Co., 2,500 tons of ore containing 1.98 percent tin was mined in 1918, however the total United States production of tin mined in 1918, exclusive of Alaska, is given as 1 ton; in 1919 none was produced.

The National Tin Corporation is reported to have mined 800 tons of ore and produced 12 tons of concentrate during the first 8 months of 1920.

Geology. - The Cowboy vein consists of quartz and mica (greisen). Cassiterite occurs in narrow seams with mica in the quartz. The seams are

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[11] Knopf, Adolph, Tin: Geol. Survey Mineral Resources of the United States, 1916, pt. I, p. 618.

[12] Knopf, Adolph, Tin: Geol. Survey Mineral Resources of the United States, 1917, pt. I, p. 65.

[13] Knopf, Adolph, Tin: Geol. Survey Mineral Resources of the United States, 1918, pt. I, p. 25.

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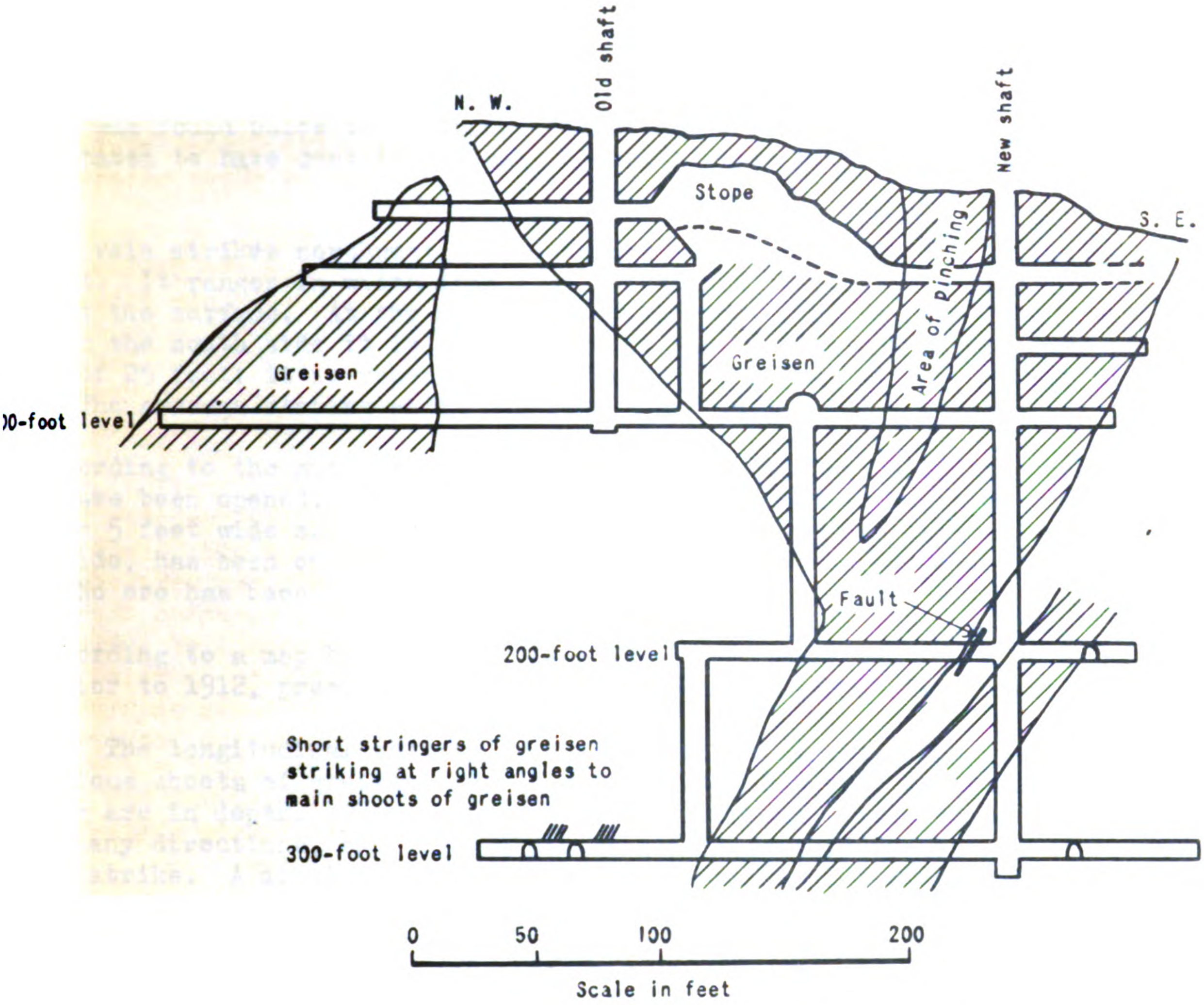

Figure 3.- Longitudinal section of Cowboy mine. (After Duncan, 1912.)

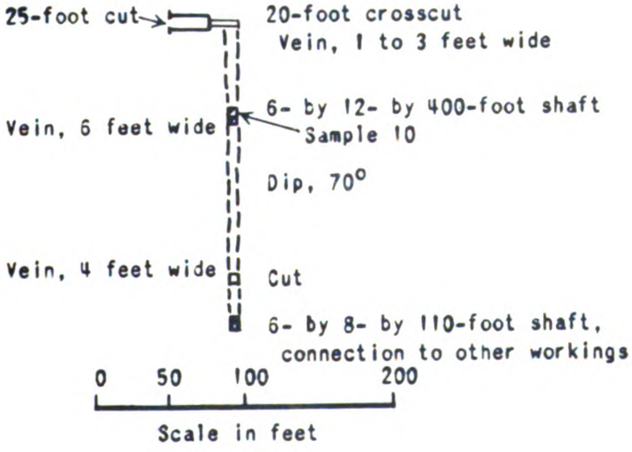

Figure 4.- Plan of Coats dike near Hill City, S. Dak. (Distances paced.)

of short vertical and horizontal dimensions and are irregular in occurrence but probably favor the footwall. A fair quantity of float tin ore and boulders was found below the outcrop. Some of the boulders were high grade; ne is stated to have contained a slab of cassiterite 6 by 6 by 11 inches in size.

The vein strikes northwest and southeast and dips 65° to 75° to the ortheast. It ranges in width from 1 to 4 feet and is about 200 feet in ength at the surface. At the north end of the shaft the vein is 2 1/2 feet ide. On the south side it is 3 feet wide at the surface and 1 foot wide at depth of 25 feet; it is reported to widen out to 4 feet at the 40-foot evel. The average stoping width has been 2 1/2 feet.

According to the authors of Tin Deposits in South Dakota,14/ two ore hoots have been opened. The one on which most of the work has been done is rom 1 to 5 feet wide and about 100 feet long. A second ore shoot, 8 to 12 nches wide, has been opened for a distance of 138 feet on the 85- (100) foot evel. No ore has been found south of the shaft.

According to a map by Duncan15/ (see fig. 3) a small stope had been ined prior to 1912, presumably by the Harney Peak company. He states:

> The longitudinal section of the mine (fig. 3) shows the various shoots of greisen, and it will be seen how very lenticular they are in depth. The schist walls show numerous slickensides in many directions, and in some places slight contortions in dip and strike. A distinct fault is noticeable on the 200-ft. level, where the greisen of shoot C has been turned round at right angles near the shaft, and has "petered out" in the west wall, while on the 300-ft. level, at the far north end, two little stringers of greisen, with a strike at right angles (roughly) to that of the main shoots, have been followed by tunnels, which proved only a rapid "petering out" in each case.

According to Knopf16/ an ore shoot which was stoped out from the 100-ot level to the surface by the American Tin & Tungsten Co. was 50 feet ng. On the 200-foot level the shoot was 77 feet long and from 1.5 to 2.5 et thick. At the time of Knopf's visit the Cowboy mine contained one ore oot 60 feet long and about 1.5 feet thick.

According to A. L. Palmer of Hill City, who was mine foreman when the e was operated by the National Tin Corporation, all ore has been mined

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/ Cummings, J. B., and Lincoln, F. C., Tin Deposits in South Dakota: Published by State Planning Board, Brookings, S. Dak., as a W. P. A. project, June 15, 1936, 35 pp.

/ Duncan, Gordon S., Contribution to the Study of the Pre-Cambrian Rocks of the Harney Peak District of South Dakota: Trans. Am. Inst. Min. Eng. vol. 43, 1912, p. 213.

/ Knopf, Adolph, Tin: Geol. Survey Mineral Resources of the United States, 1918, pt. I, p. 25.

above the 100-foot level. A stope 70 feet long between the 200- and 100-foot levels is two-thirds full of ore; it was mined by shrinkage stoping and is broken to within 20 feet of the 100-foot level. He states that the same ore shoot was 70 feet long on the 300-foot level and that preparations had been made to stope it.

If it is assumed that the 12 tons of concentrate produced from 800 tons of ore by the National Tin Corporation contained 50 percent metallic tin and that 70 percent was recovered the grade of the ore mined would have been 1.07 percent metallic tin. No authentic information could be obtained regarding the grade of the ore remaining in the mine.

Hess[17] states that 5,000 tons of ore that was hauled from the various prospects and put through the mill in 1892 yielded only 0.25 percent tin. The result contrasted sharply with estimates made by various men who had examined the property and was attributed to loss through maladjustment of new machinery. The estimates made by five examiners ranged from 1 to 1.74 percent. One professor gave the results of his assays as 6 percent. Hess states further that the entire output of this company was probably less than 5 tons of metallic tin, or much less than the weight of the gold coin put into the venture.

Development Work. - Underground development work comprises a 300-foot, three-compartment shaft with an inclination of 68°, a 100-foot shaft 160 feet to the northwest, 2,150 feet[18] of lateral workings, and a number of raises. A longitudinal section of the mine is shown in figure 3.

The 100-foot shaft was sunk before the Harney Peak company obtained the property. The National Tin Corporation added the third compartment to the 300-foot shaft and did 600 feet of lateral work. The workings are caved at the surface and inaccessible.

The Harney Peak company built a railroad spur to the property, erected ore bins, and equipped the mine with steam boilers, a compressor, and a hoist. The National Tin Corporation reequipped the mine and built a 50-ton ore bin. This company and its predecessors spent $240,000 buying ground, rebuilding the mill, and mining; returns were reportedly small. Work was discontinued in September 1920 when the mine was flooded. All equipment has been removed.

Mining. - The National Tin Corporation hauled the ore by teams and wagons 1 1/2 miles to a railroad spur on the Burlington at a cost of $0.50 per ton. It was then transported by rail to the mill at a further cost of $0.25 per ton. According to Tin Deposits in South Dakota the total cost of producing the ore, including transportation, was estimated as $10 per ton. The shrinkage method of stoping was used.

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[17] Hess, F. L., Tin, Tungsten, and Tantalum Deposits of South Dakota: Geol. Survey Bull. 380, 1909, p. 131.

[18] Cummings, J. B., and Lincoln, F. C., work cited in footnote 14, p. 15.

The average price of tin was 56 cents for the first 8 months of 1920 when the Cowboy mine was producing. If it is assumed that 18 pounds of tin was recovered from each ton of ore the value per ton at New York quotations would have been $10.08. As the cost of mining the ore is reported to have been $10.00 per ton, evidently the operations were not profitable. Moreover, the cost of most of the development work previously had been written off.

Milling. - The mill of the Harney Peak company[19] was constructed by Fraser and Chambers in 1893 at a cost of $250,000.

The milling plant of the Hill City Tungsten Producers Co. was installed in the old Harney Peak mill building. Bland states:

> An 800-ton, six-compartment storage bin was built under the end of the railroad spur, which was relaid with steel for a quarter of a mile from the main line of the Hill City-Keystone branch of the C.B. & Q. railroad. Cars bringing ore from the Cowboy tin mine, and tungsten custom ore from the Lead-Deadwood district, dump into the bin. The ore is then trammed into the head bin above the crusher, thence passing through the mill as follows: 1-1/2-inch grizzly, 11- by 14-inch jaw crusher; trommel, 36- by 16-inch Chalmers & Williams rolls, trommel, 30- by 14-inch Allis-Chalmers rolls, Vezin sampler, sample to coffee-mill grinder, reject to 60-foot elevator. The elevator delivers 96 percent through 1/3-inch ring, dry product, to 150-ton bin, which serves to make the crushing and concentrating departments independent of each other, the crushing machinery being designed to run one shift to supply the concentrators for three.
>
> Ore is fed from the intermediate bin to three trommels in series; oversize from the first (running from 3- to 5-mesh) to Harz jigs, from the second (5- to 8-mesh) to Harz jigs, from the third (8- to 16-mesh) to Wilfley tables, undersize to cone deslimer, oversize to 80-mesh duplex Callow screen, from which the undersize goes to a Deister-Overstrom table, while the deslimer, 16- to 80-mesh oversize, passes to Bunker Hill screens, which split the feed into 16- to 24-, 24- to 40-, and 40- to 80-mesh sizes for Wilfley tables. The deslimed feed goes to the rag plant.
>
> The jig middling is reground in 30- by 40-inch Allis-Chalmers rolls, the product from which is elevated to the first trommel, rejoining the ore stream at its beginning. The middling treatment was designed for high-grade custom ores from the Lead-Deadwood district, as follows: Middling from jig to rolls, middling from all other tables to a storage tank above the desliming cone. The middling from the 8-mesh down to slime is repassed through the screens for resizing. The middling obtained in rerunning the original middling is reground, the coarse sand going to a National disk pulverizer and the finer sand to a 4-foot ball mill. This

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/ Bland, John, Tin and Tungsten in South Dakota: Min. and Sci. Press, vol. 114, Mar. 31, 1917, pp. 441-444.

treatment was designed, also, for the "dike" tungsten ores, which are described later. This flow sheet shows close mechanical sizing, instead of water classification, and also a complex treatment of the middling.

Two months' pilot-mill experimentation in the old Black Hill tungsten mill proved the advantage of close sizing and separate middling treatment. Tungsten milling involves an all but a new principle in gravity concentration - that of producing clean concentrate. The extremely high penalty for insoluble in the concentrate warrants unusually expensive treatment to avoid it, and the close sizing of ore and middling was found to be indispensable in securing this result. Sliming must be avoided for the same reason. That accounts for the attempt to secure the greatest possible size of concentrate particle and for screening before each crushing in order to remove ore needing no reduction in that unit. The rag plant, through which all the sand passes before reaching the tailing dump, has been found indispensable here as it is in the Boulder district, Colorado. A one-cell flotation unit has been installed for experimentation on cassiterite, wolframite, and hübnerite.

In 1918 the equipment was altered to reduce the capacity from 200 to 100 tons per day and to reduce the loss of cassiterite by sliming. A smelter was built at the mill, but it was not successful, principally because of a loss of 15 percent of the tin in smelting. Concentrates were shipped to the smelter of the American Smelting & Refining Co. at Perth Amboy.

According to Palmer the ore slimed badly and the recovery was about 70 percent. The highest milling rate in 1 day was 50 tons. Most of the ore milled was quartz as mica in the ore tended to carry cassiterite away on the tables.

A grab sample of a remnant of the sand tailings from the mill was assayed; the returns showed 0.08 percent tin. This would check Palmer's statement that most of the losses were in the slimes. Most of the tailing pile has been removed for use as sand.

Possibilities for Future Production. - The Cowboy vein appears to have been fully developed on three levels. According to reports cassiterite has been found on the 300 - the lowest level.

An ore shoot 70 feet long and 2 feet wide would produce 11 tons of ore per foot of depth. If Palmer's recollection of the ore shoots is assumed to be correct, about 20 feet or 220 tons of ore remain unbroken, and about 500 tons are still in the 200-foot-level stope (the level interval is 90 feet). If the shoot partly stoped on this level extends without decrease in size to the 300-foot level this block would supply an additional 1,000 tons of ore.

The best estimate that can be made from the incomplete data available is that the ore shoot will contain about 1 percent tin; on this assumption

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the stopes on the 200-foot level would produce 14,400 pounds; if the same grade were used and it were assumed that the shoot extended to the 300-foot level, the block between the 300- and 200-foot levels would contain an additional 20,000 pounds or a total of 34,400 pounds of tin. As these figures are based partly upon incomplete data and partly on conjecture, they lo not justify much confidence.

Duncan states that the shoots of greisen are lenticular in depth, and igure 3 shows a split in the dike on the 300 (275-foot) level. Moreover, nly part of the dike material contains tin.

Sinking the shaft to find new ore shoots or to ascertain that the ore orked above persists downward, would appear justified only if the need for in were imperative.

Should it be desired to make an assay map, pull the material broken in e 200-foot stopes, mine the vein between the 300- and 200-foot levels, or ink to a lower level a complete new surface plant would have to be installed irst, the mine dewatered, caves caught up, and the underground workings epaired.

Estimates of the cost of rehabilitating the mine must be based mainly conjecture, as the condition of the underground workings is not known.

A satisfactory surface plant would cost about $3,800 installed, as llows:

Gasoline-driven hoist, installed including foundation .	$1,700
Sinking pump, air-driven	525
Skip, 20-cubic foot capacity	220
Skip rails, 700 feet	128
Car	145
Water column, 3-inch, 350 feet at $41.68 per 100 feet including freight	173
Air line for shaft, 2-inch, 350 feet at $20.25 per 100 feet including freight	130
Hoisting cable, 5/8-inch, 500 feet at $0.226	113
Blacksmith-shop tools	175
Hand tools	25
Head frame	85
Building	250
Miscellaneous	100
Total	3,769

Air for the pump would be supplied by a portable air compressor, which bably could be rented for $75 per month.

The cost of a surface plant that could be used later for regular mining ations would be as follows:

Caterpillar, 80-hp. Diesel-electric, installed	$5,934
Compressor, 510-cubic foot capacity ($1,640), inslalled	1,840
Hoist (1,083), installed	1,345
Air receiver, 2 1/2 by 7 feet	150
Water column...	173
Air lines, 700 feet	260
Hoisting cable	113
Blacksmith shop	175
Hand tools	100
Building	500
Skip	220
3 1-ton cars	385
1 jackhammer - sinking	215
1 jackhammer	90
1 drilling column	80
Drill steel, 2,000 pounds	200
Miscellaneous	500
Total	12,280

Although the main shaft is blocked near the collar, there is no surface evidence that it is badly caved. According to Palmer the water level is 60 feet below the collar, and the water was bailed out daily when the mine was operating.

As the mine was being dewatered the shaft would have to be repaired and equipped with track and water and air lines; the 200 and 300 levels could be reopened and equipped when reached. The cost of this work would be $5,000 to $10,000 depending upon how badly the ground is caved.

The next step would be sampling and making an assay map. Samples cut by hand at 5-foot intervals, would cost about $6.50 each, including assaying, to which must be added hoisting and pumping expense of about $7.50 per day. The cost of drilling and breaking samples weighing 300 pounds would be about $19.55 each, including concentrating and assaying. If 150 such samples were taken the cost of sampling would be about $3,000.

If the results of sampling were favorable and more ore was to be developed, the shaft would be sunk another 100 feet and another level run.

Shaft sinking would cost about $80 per foot and drifting $15 per foot; all surface labor and supervision would have to be charged against the sinking and drifting.

Coats

The Coats dike is about 1 1/2 miles southwesterly from Hill City. It was discovered by George W. Coats when he was a boy and located by his father S. H. Coats, on September 18, 1884. It was sold to a New York company headed by Samuel Untermyer; this company sank a 110-foot shaft and later (in 1899) sold the claim to the Harney Peak Tin Mining & Manufacturing Co. The dike is on one of three patented claims.

The Coats was included in the Cowboy group when it was operated by the arney Peak company. This company built a railroad spur to the ground and ank a new 400-foot shaft. A small stope of fairly rich ore was mined out n the 60-foot level in 1889. Later the ground was acquired by John Kennedy f Philadelphia and presumably now belongs to his estate. No work has been one on the property since it was owned by the Harney Peak company. It was nspected July 16, 1938, by the author, who was accompanied by George Coats.

The development work consists of a 6- by 12-foot shaft 400 feet deep, a - by 8-foot shaft 110 feet deep, and 4- by 6-foot adit 20 feet long with a 5-foot open cut in front. (See fig. 4.)

Drifting has been done on the 60 and 100 and, possibly, other levels. he main shaft is timbered solidly to a depth of 40 feet, where it is blocked ith trash. The water level is at 50 feet. Thomas[20] states:

> A shaft has been sunk on a ledge, which is from 6 ft. to 8 ft. wide, near the surface. At the 60-ft. level it retains its size for 120 ft. south of the shaft, but to the north of the shaft for 100 ft. in length it is much smaller and in the end is very small and poor. At the 125-ft. level the ledge is about 6 ft. wide for 120 ft. in length to the south of the shaft, and beyond this for 60 ft. in length it is much smaller. To the north of the shaft at this level it is only from 2 in. to 6 in. wide for 70 ft. in length. At the 225-ft. level the ledge is 6 ft. wide for about 100 ft. in length, and for the remaining 400 ft. driven at this level it is very small and poor. The shaft is sunk to the 400-ft. level, but the ledge has not been seen below the 225. Judging from its appearance there, I should expect it will be found to be smaller at the deepest point. Samples taken from the large heaps at the surface produced 18 lb. of black tin per ton.

The Coats dike at the surface is 1 to 6 feet wide and about 200 feet ng; it dips 75° to the east. The vein at the collar of the 400-foot shaft 6 feet wide and at the other shaft, 4 feet; where cut in the adit, it was foot wide on the north side and 3 feet wide on the south. It does not show ediately above at the surface. The dump of the 400-foot shaft consists stly of schist. Coats stated, however, that the vein was faulted 10 feet the 100-foot level and that the shaft below was in the hanging wall. Most the vein material is quartz.

The cassiterite in the higher-grade material is associated with pearly ca. In places the dike contains seams of graphite. Coats reports that y high-grade boulders were hauled away, some of which contained slabs of ssiterite as large as a man's hand.

The dump of the shaft at the lower end of the dike contains about 400 500 tons of vein material that shows a little cassiterite. A sample of

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Thomas, Josiah, Harney Peak Tin Mines: Eng. and Min. Jour., vol. 54, 1892, p. 514.

the dump taken by Palmer was of milling grade. The writer chipped a sample 6 feet across the vein at the collar of the 400-foot shaft; a 6-inch streak contained visible cassiterite grains. The sample assayed 0.08 percent tin.

Possibilities of Future Production. - On the basis of present information, this mine does not appear to be very promising for future production from the zones and horizons so far explored. The old-timers in the district have no stories of ore having been found in any of the lower levels. Probably about 100 tons of vein material of milling grade could be sorted from the dump at the 110-foot shaft.

Although nearly 50 years old, the main shaft does not appear badly caved; at least, there is no surface subsidence around it. To ascertain the extent and grade of the deposit the main shaft would have to be cleaned out, dewatered, and retimbered. A surface plant, including a power plant, hoist, and pump, would have to be installed before work could begin. The cost of the surface plant and necessary tools would be about $3,300. Retimbering and repairing the shaft would cost $15 to $50 per foot, depending upon how badly caved it is. Reopening lateral workings would probably cost $5 to $10 per foot.

After the workings were reopened the next step would be to sample the vein; the cost per sample would be about $10.25. The best sample interval on the narrow vein would be 5 feet. Apparently about 150 feet of drifting has been done on the 100-foot level; the footage of drifting on the lower levels is problematical but probably is small.

Gertie

The Gertie is on one of two patented claims; it is on the highway and the Burlington Railroad about 1 1/2 miles south of Hill City.

The Gertie claim was located in August 1883 by Coats and McClure. The gulch below the vein was placer-mined for stream tin. It was part of the Harney Peak holdings and later was obtained by E. C. Johnson, who operated it in 1908 as the Gertie Mining & Milling Co. This company built a mill but made no appreciable production. The last recorded owner was the Citizens Bank & Trust Co., which is now defunct. No title is recorded at present. The author, in company with George W. Coats, visited it July 16, 1938.

The Harney Peak company sank an inclined shaft to the 400 level, ran drifts in both directions, and broke great quantities of pegmatite, most of which remained in the stopes in 1908.[21] Levels were run at 100 (70), 200, 300, and 400 feet; stoping was done on all levels.

Some of the "swell" from the shrinkage stopes probably was milled by the Harney Peak company; 1.8 tons of concentrate (see table 2) was produced by the Gertie Mining Co.

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[21] Hess, F. L., Tin, Tungsten, and Tantalum Deposits of South Dakota: Geol. Survey Bull. 380, 1909, p. 1136.

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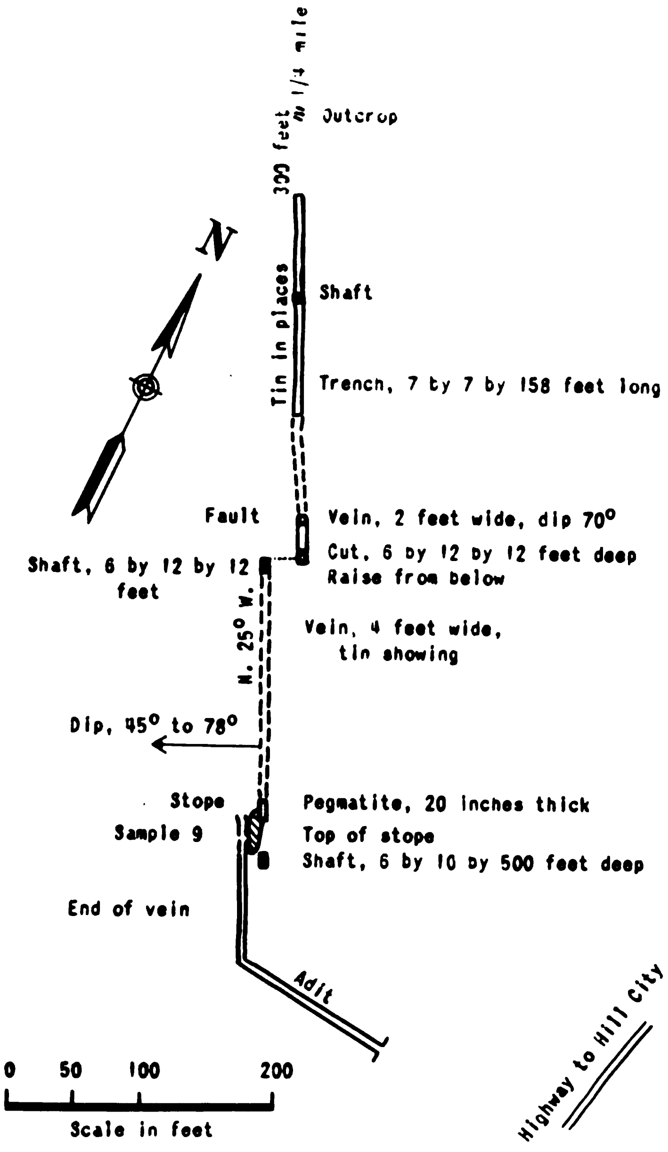
300 feet
≈ 1/4 mile
Outcrop
N
Shaft
Tin in places
Trench, 7 by 7 by 158 feet long
Fault
Vein, 2 feet wide, dip 70°
Shaft, 6 by 12 by 12 feet
Cut, 6 by 12 by 12 feet deep
Raise from below
N. 25° W.
Vein, 4 feet wide, tin showing
Dip, 45° to 78°
Stope
Pegmatite, 20 inches thick
Sample 9
Top of stope
Shaft, 6 by 10 by 500 feet deep
End of vein
Adit
Highway to Hill City
0
50
100
200
Scale in feet

Figure 5.- Plan of Gertie vein near Hill City, S. Dak.

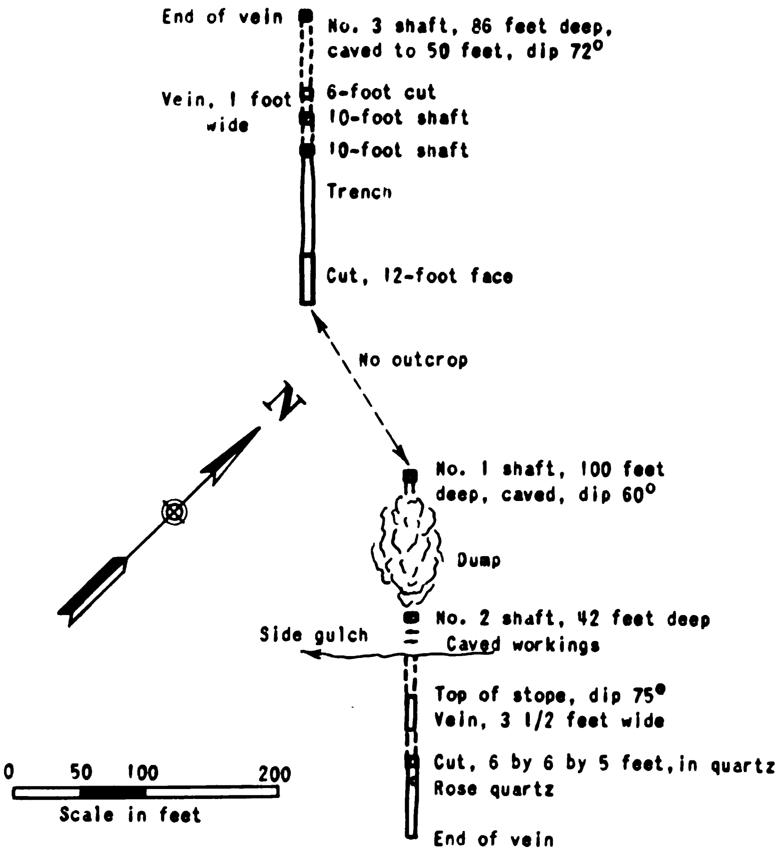

Figure 6.- Plan of Mohawk vein near Hill City, S. Dak.

Johnson sank the shaft to the 500-foot level, where it was reported that the dike was more than 8 feet thick, but the quantity of tin was disappointing. The surface work shown in figure 5 was also done by Johnson. A 200-foot adit has been run to the shaft on about the 70-foot level.

The hoist was set at the collar of the shaft, and hoisting was done to the 70-foot level. All surface equipment has been removed from this mine, as from the other tin mines in the Southern Hills.

At the surface the width of the vein is 1 to 4 feet and averages about 2 1/2 feet. The dip is 45° to 78° to the west. The 500-foot shaft is at the south end of the outcrop. The vein is 18 inches wide at the collar of the shaft and narrows to 1 inch at 20 feet; at the 70-foot level it is 2 1/2 feet wide. The pegmatite extends 20 feet to the south of the shaft on the adit level. A stope 35 feet long in which 3-foot stulls were used extends lmost to the surface just north of the shaft and is full of broken pegmatite. he 70-foot level is caved beyond the stope. At a point 150 feet to the orth of the shaft the dike is faulted 25 feet to the east, and from there for about 300 feet it is disclosed by cuts and trenches.

A small pegmatite outcrop is in line for about 300 feet with another xposure about one-fourth mile to the north; the two northern outcrops do ot contain any tin.

Scattered crystals of cassiterite were noted in the outcrop in the outh segment of the dike and to the north end of the trench on the north egment. A 15-foot sample was taken along the dike on the 70-foot level low the stope and on the opposite side of the drift where the average dth of the vein is 26 inches. No cassiterite was noted in the vein where e sample was taken; the assay showed 0.01 percent tin.

Most of the dump at the adit has been hauled away for road material. ats found several pieces of the vein matter containing cassiterite rystals in the remaining part of the dump.

According to H. G. Mills, who worked on the 400-foot level of the mine, 400-foot drift 4 to 5 feet wide was run on the vein, and evidence was esented in a lawsuit that the vein contained an average of 0.25 percent n for the full distance. He also states that on the 300-foot level one ction 40 feet long and 5 feet wide contains high-grade tin ore which is ill in place.

Hess states:[22]

> The dike was probably injected between the foliae of the schists in a pasty condition, and the stresses developed through its being forced into place were not equal at all points, so that here and there the schists forming the sides of the dike were pressed almost together and in places met, squeezing out the peg-

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Hess, F. L., work cited in footnote 21, pp. 136-137.

matite for some distance. This left the dike in irregular lens-shaped bodies. The different phases are excellently shown in the Gertie workings, and a good illustration of the phase in which the dike is wholly parted was printed in an article by Arthur J. Morse.[23] Precisely similar phases are shown diagrammatically in figure 7, drawn from a sketch of a quartz vein in the Forest City mine. That the squeezing took place before the crystallization and solidification of the dike was completed is shown by the fact that there is no noticeable distortion or crushing of the crystals.

The pegmatite, like all the pegmatites of the region, is light-colored and fine-grained through most of the dike. The quartz is glassy, partly colorless, and partly with a slight smoky tinge. The feldspar is probably albite in the main, though a thorough examination has not been made. The mica is muscovite and is peculiarly clear. In places the small books are almost as transparent as quartz, showing that there has been little or no bending or crushing of the rock since the crystallization of the minerals. Cassiterite and tourmaline occur in small amount as accessory minerals. No others are visible in the specimens collected, beyond a few small bright-green stains in the muscovite and a few rust stains. The dike is in places "frozen" to the walls, and silicification extends into the schist an inch or more.

The cassiterite is dark brown in thin sections, but appears to be black in the rock. The particles are of irregular shape but tend to elongated tabular forms which vary in size with the texture of the pegmatite. In the fine-grained portions of the dike the cassiterite is in minute particles which may be barely visible. In the coarser portions of the dike the particles reach an inch in length, three-eighths of an inch in thickness, and two-thirds of an inch in width. So far as seen the tourmaline also is black, and being in small particles it is with difficulty distinguished from cassiterite. It does not seem to accompany the cassiterite in the coarser parts of the dike but occurs in the finer-grained parts, which makes distinguishment more difficult, particularly as the tourmaline crystals are short and those of cassiterite are elongated as compared with the usual habit of these minerals.

The cassiterite occurs in shoots which apparently are not very continuous in any direction, and no rules are known for their occurrence. In this dike, as in the other tin-bearing pegmatites of the region, many parts seem to be practically barren of tin.

The rock is easily crushed, and aside from the saving of slimed cassiterite probably the greatest difficulty in handling the ore arises from the large amount of mica it contains.

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[23] Morse, A. J., The Harney Peak Tin Mines: Eng. and Min. Jour., vol. 57, 1894, p. 463.

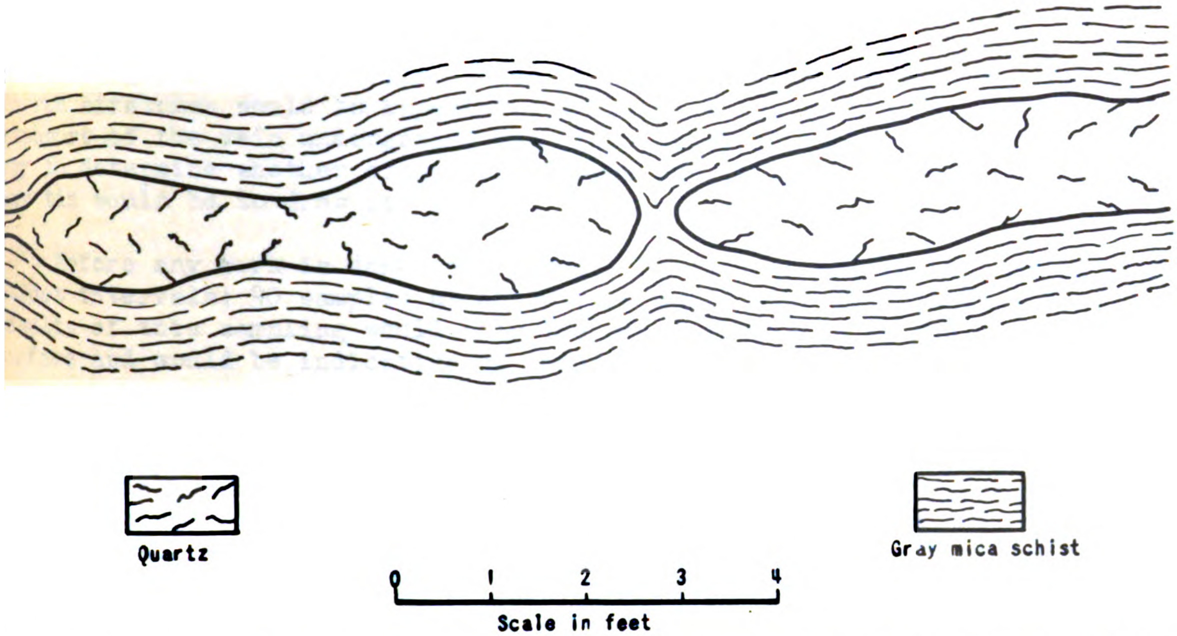

Figure 7.- Diagram of quartz vein in Forest City mine, 1.5 miles east of Oreville, S. Dak. (After Hess.)

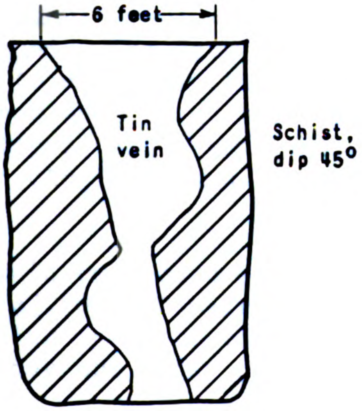

Figure 8.— Sketch showing tin-bearing pegmatite dike in face of cut at Mohawk vein near Hill City, S. Dak.

Possibilities of Future Production. - The Gertie dike appears to have been fully developed by the early operators. Although the vein contains some cassiterite, known exposures are of low grade. It is doubtful if the broken pegmatite contains over 4 or 5 pounds of tin per ton.

Not enough data are available to permit an estimate of the size of the tin-bearing parts of the vein. From an inspection of the outcrop, long, arren stretches would be expected. A sample taken of the only accessible exposure of the vein underground was practically barren of tin. The only ay to determine whether or not the broken ore in the old stopes contained ny tin would be to draw it out.

Before any work is done underground the outcrop should be sampled at -foot intervals; 90 samples at $6.50 each would cost about $585. The esults of this sampling would show the quantity of tin in the vein at the urface and would be indicative of underground conditions.

The next step would be to reopen the 70-foot level. To do this a new rack, car, and hand tools would be required. Catching up the caved parts f the drift would be more expensive than driving it in the first place. e cost of rehabilitating 400 feet would probably be $4,000.

If the results of the work on the 70-foot level were encouraging the xt step would be to unwater, repair, and timber the shaft and lower levels ogressively.

From its appearance at the surface and at the adit level the shaft does t seem to be badly caved; it has been standing without attention for 20 ars. Water from the shaft is running out of the adit. According to Hess, large part of the dike was stoped. The back would be partly supported by e broken ore that was allowed to remain in the stopes; large stulls were ed in the one stope that can now be seen. It is probable, however, that ight has developed on these stopes, and recovery of the broken ore would more expensive than mining in virgin ground. The one level accessible s caved under a stope.

A complete surface plant would be needed before the shaft workings were aired; this would cost about $3,300. Repairing the shaft probably would t $10 to $50 per foot, depending upon its condition. The cost of toring the lower levels, if they are badly caved, would average about $15 foot.

Tenderfoot

The Tenderfoot mine is in Custer County on the Burlington Railroad and Deerfield-Hill City road, about 9 miles from Hill City. The deposit is of a group of four patented claims, the Japanzy, Czar, Czar No. 1, and r No. 2. It was part of the Harney Peak holdings and later was acquired E. C. Johnson while he owned the Gertie mine. Bert Robinson, Custer, S. ., states that he has held title to the patented claims for the past 8 or years by virtue of a tax sale by Custer County.

The ground was inspected July 31, 1938, in company with Robinson and H. G. Mills.

The development comprises a 300-foot shaft, two adit crosscuts to it, and drifting on two levels. According to Robinson the lower adit is 996 feet long to the vein; drifts were extended 300 feet in either direction to the limits of the dike. He further states that 35- or 40-foot raises were driven in three or four places. The lower adit extends from the level of the creek bed at an altitude of 5,635 feet. The altitude of the collar of the shaft is 5,860 feet and of the intermediate adit, 5,730 feet. The shaft and upper adit are caved, but with the exception of one fall the lower adit is accessible. A railroad spur was run to the portal of the lower adit in the early days. A steam engine and compressor were installed and buildings erected at this place.

The length of the dike at the surface is about 500 feet as traced by outcrops and float. The shaft was sunk and raised on the dike. At the collar of the shaft the dike is about 6 feet wide; the strike is N. 30° W. and the dip 60° to the east. Thomas[24] states:

> Some very rich boulders - richer for tin than I observed in any part of the property - are scattered over the surface. The Japanzy tunnel, driven 1,000 ft., intersected the ledge 300 ft. below the surface. This tunnel has been continued southward on the ledge 600 ft. For about 300 ft. in length the ledge is from 6 ft. to 8 ft. wide, but for the remainder of the distance to the end it is small and poor, being only from 2 in. to 4 in. wide. In the northern tunnel, which has been driven 400 ft., nothing of value has been met with.

The slope below the shaft and upper adit is covered with float pegmatite but no tin could be found in it or in the part of the outcrop examined. Apparently, little drifting was done on the upper level as the upper adit dump contained relatively little dike material; the pegmatite contained no tin. No tin was found in place where the vein was exposed in the upper part of the shaft or in the dump from the shaft. The shaft was started in the hanging wall where the top of the dike is covered with about 6 feet of overburden. Only about 50 or 60 tons of ledge matter had been hoisted from the shaft; it is blocked at a depth of about 35 feet.

A large part of the lower dump has been hauled away for road material. A diligent search revealed a few fragments of pegmatite that contained cassiterite crystals.

Apparently the occurrences of cassiterite are sparse and widely separat The few particles of cassiterite found, however, were relatively large.

According to Coats a boulder weighing 2,200 pounds, high in tin, was shipped from the upper claim of the group in the early days.

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[24] Thomas, Josiah, Harney Peak Tin Mines: Eng. and Min. Jour., vol. 54, 1892, p. 536.

According to Steve Ainsley of Custer, who worked in the upper adit in 1890, five or ten 25-ton cars of dike material were shipped to the mill, all from development work and mostly from the upper tunnel. Ainsley is of the opinion that no stoping was done.

Apparently not more than 250 tons of pegmatite has been shipped from he property; the percentage of tin it contained is not known. Available nformation indicates that the vein has been explored on two levels, but no ommercial ore has been found.

Possibilities of Future Production. - If the mine were investigated for possible future emergency production of tin the first step would be to ample the parts of the vein in which tin could be identified by sight. The ower adit could be reopened at comparatively little expense. The samples hould be taken across the vein at 5-foot intervals; the cost per sample ould be about $8.25.

Addie

The Addie mine is on the old Hill City-Keystone road about 3 miles from ill City. It was a part of the Harney Peak holdings and is now held by the w Eldorado Mines, Inc., Rapid City, S. Dak. (Dr. P. Kersten, president). e mine is on a patented mining claim.

The development work comprised an 800-foot three-compartment shaft (now ved), drifts, and raises. The work was done by the Harney Peak company. is reported that the shaft was sunk on a straight line and that the dike which it was started was lost in the lower levels. A raise was run to e surface from the first level 200 feet south of the shaft.

When the mine was inspected by Thomas[25] in 1892, the conditions underound were as follows:

> Large boulders, some of which are rich in tin, are scattered over the surface. Pumping, hoisting, and air-compressing machinery have been erected on this mine, and a shaft has been sunk to a depth of 600 ft. The 135-ft. level is driven 700 ft. and the ledge, which is of a granitic character with a good deal of mica, varies in width from 6 ft. to 9 ft. for 200 ft. in length. In the remainder of the 500 ft. driven the lode is either very small, being only 3 in. or 4 in. wide, or is composed principally of schorl with scarcely any tin. At the 200-ft. level the ledge in some places is 9 ft. wide, but for the greater part of the distance driven it is very small and of no value. At the 300-ft. level nothing has been discovered for the whole length that will pay to work, and the ledge, which in the upper levels was from 6 ft. to 10 ft. wide, has dwindled down to a small leader of 1 in. or 2 in. in thickness. In the southern end, which is now being driven, the leader has increased in size but does not contain

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Thomas, Josiah, work cited in footnote 24, p. 513.

much tin. At the 400-ft. level, which is driven 200 ft. south of shaft, there is merely a wall, with sometimes a very small leader on it. Crosscuts are now being driven east and west in order to prove whether the ledge has been shifted from its usual dip, but, although these levels have been driven 70 ft. east and 60 ft. west, nothing but country rock has yet been met with. The ledge has not been seen below the 400-ft. level, but the shaft is sunk 200 ft. deeper at a greater inclination than the ledge so that a crosscut will have to be driven east at the 600-ft. level in order to intersect it.

A railroad spur was extended to the property, and ore bins were constructed. The remnants of the ore bins are still on the ground. The mining plant and equipment have long since been removed.

The dike at the collar of the caved shaft is about 6 feet thick. The strike is to the northeast and the dip about 65° to the northwest. Most of the workings were in schist, but a dump containing about 1,500 tons of pegmatite has been kept separate. A hundred or more tons of the dump have been hauled away, probably for road material. A few pieces of pegmatite containing tin were noted on the dump. James H. Smith of Hill City, who is interested in the company, sorted a few tons of ore from the dump and hauled it to the custom mill of the Black Hills Tungsten Co. at Hill City about 20 years ago. Doubtless most of the tin-bearing material exposed was removed by Smith. He states that sorted material that he hauled away ran 2 1/2 percent tin. Probably an additional 100 or 200 tons of pegmatite running 1 percent tin or better could be sorted from the dump.

It is reported that the Harney Peak company milled a few carloads of ore from this mine.

The property was visited August 1, 1938, in company with James N. Smith and H. G. Mills.

Possibilities of Future Production. - Apparently the dike was fully explored by the underground workings to a depth of 400 feet and the cassiterite bunches were small and widely scattered.

The main shaft, which is about 50 years old, is caved; a large crater exists at the surface. From its appearance a new shaft could be sunk for less than it would cost to reopen the old one.

White Whale Group

The White Whale, Colossal, La Grande, and Mewonitok claims have been patented as the White Whale group. The group was a part of the Harney Peak holdings. The claims have been sold recently by Pennington County for back taxes; the Mewonitok claim was bought by Victor T. Jepson and Carl LeSueur of Rapid City. The titles to the other claims were not checked. The group is near the old Hill City-Keystone road, about 1/2 mile from Hill City. The Harney Peak company did the development work on the claims, except for a 50-foot tunnel which was run by the National Tin Corporation in 1920.

The group was visited August 3 with H. G. Mills. A map was not avail- ɔle when the claims were inspected. Mills pointed out dikes and gave their mes.

Colossal. - The Colossal dike is the nearest one of the group to the ghway; it is 10 to 15 feet wide. A 20-foot shaft has been sunk in the dike a ridge and a 75-foot adit run southeasterly on the vein toward the shaft om the lower end of the dike. The adit is caved, and no tin was found on e dump. A little cassiterite was present in one spot in the outcrop near e shaft.

Mewonitok. - The Mewonitok dike is the second one from the Colossal; it 8 feet wide and cuts across a small gulch leading toward the highway. It rikes southeast-northwest and is nearly vertical. A 300- or 400-foot ift was run, a 40-foot shaft sunk in the main dike, and an open-cut run in 3-foot parallel dike about 50 feet away. The adit probably extends to a int opposite the shaft; it is caved at the portal. The shaft was cleaned t about 1910. No tin was noted on the adit dump or at the shaft.

About 1 ton of pegmatite, apparently excavated from the solid, was piled the dump of the cut on the 3-foot dike; it contained 3 or 4 percent tin. tin was found in place. According to Mills, a few boulders of tin ore om below the 8-foot dike were included in the 50-ton shipment to England, t there has been no other production. Some boulders of tin were also und across the gulch, but a vein was not disclosed.

White Whale. - The White Whale dike is up the hillside and parallels the wonitok. It is about 15 feet wide and 200 feet long, outcrops boldly, and sists of glassy quartz with narrow lenses of feldspar containing seams of a. A 75-foot incline shaft has been sunk on the footwall with a crosscut the hanging wall; it is still open. The incline on the ledge starts at then flattens to a 45° slope. The footwall is very well-defined. The ntry rock is schist. Cassiterite was associated with mica in a few frag- ts of vein material in the dump; one specimen of necronite contained cas- erite. No tin was found in the outcrop.

Possibilities of Future Production. - s no tin was noted in place, pling the outcrop would not be justified. If future work were contemplated first step would be to put a ladder in the White Whale shaft and examine dike for tin occurrences. Parts of the dike where tin is visible should n be sampled. The next step would be to clean the adits on the Colossal Mewonitok dikes and the shaft on the Mewonitok and to sample parts of vein containing tin. The rock is hard, and probably only the portals of adits are caved; they could be opened up for about $300, the shaft ned out for about $250, and samples taken for about $15 each.

Mohawk

The Mohawk mine is on a 300- by 1,500-foot claim on Allen Gulch, one- mile west of Hill City. The Mohawk claim is the only one of a patented p of six claims on which tin has been found. The Mohawk was located in st 1883 and was the first location of tin in the Hill City district and second in the Black Hills.

The Mohawk was a part of the Harney Peak company holdings and was worked by that company. The group of claims is now owned by Pennington County for nonpayment of taxes. It was advertised for sale in the autumn of 1937; but there were no bidders, as a minimum price was set by the county. The previous owner was the National Tin Corporation. The Harney Peak company built a railroad spur to the property.

The ground was inspected by the writer July 16, 1938, in company with George W. Coats.

The development work is as follows:

No. 3 shaft, 18 by 3 by 86 feet deep.
Cut, 3 by 6 by 6 feet deep.
Shaft, 4 by 6 by 10 feet deep.
Shaft, 4 by 6 by 10 feet deep.
Trench, 3 1/2 by 2 by 75 feet long.
Cut, 4-by 35-by 12-foot face.
No. 1 shaft, 5 by 9 by 100 feet deep caved.
No. 2 shaft, 42 feet deep, caved.
Cut, 6- by 6- by 5-foot face.

In addition, several hundred feet of drifting has been done from the shafts.

The surface work and sinking of No. 2 shaft were done by the Harney Peak company. (See fig. 6, p.24) In 1917 the National Tin Corporation cleaned out the old workings; the No. 1 shaft was sunk, and 600 feet of drifting was done. According to A. L. Palmer, of Hill City, who was mine foreman, a drift was run 350 feet to the northwest, of which 120 feet was along the vein. A raise was run 86 feet to the surface shown on figure 6 as shaft No. 3. The old company workings were extended to the south, and the stope which is now open at the surface was mined and the ore milled with that from the Cowboy. This was on a small ore shoot that raked at an angle of about 45° to the northwest.

Equipment consisted of a steam boiler, air compressor, and hoist, which have been removed. The Harney Peak company built a railroad spur to the property.

The Mohawk is one of the small pegmatite dikes. It is 1 to 4 or 5 feet wide and about 550 feet long. The vein pinches and swells. (See fig. 8.) It strikes easterly and westerly and dips 60° to 75° to the north. The schist country rock has the same strike and dips about 45° to the south. For about 200 feet isolated crystals of tin can be seen in the outcrop. Any material of high enough grade to mine has, of course, been removed. Where discovered just below No. 1 shaft, the vein outcropped to a height of 6 or 7 feet; the outcrop was a good grade of tin ore. According to Coats, boulders in the gulch contained as much as 50 percent metallic tin. Although isolated crystals of cassiterite are found in quartz at the southeast end apparently the ore, as indicated by float, consisted principally of mica and cassiterite

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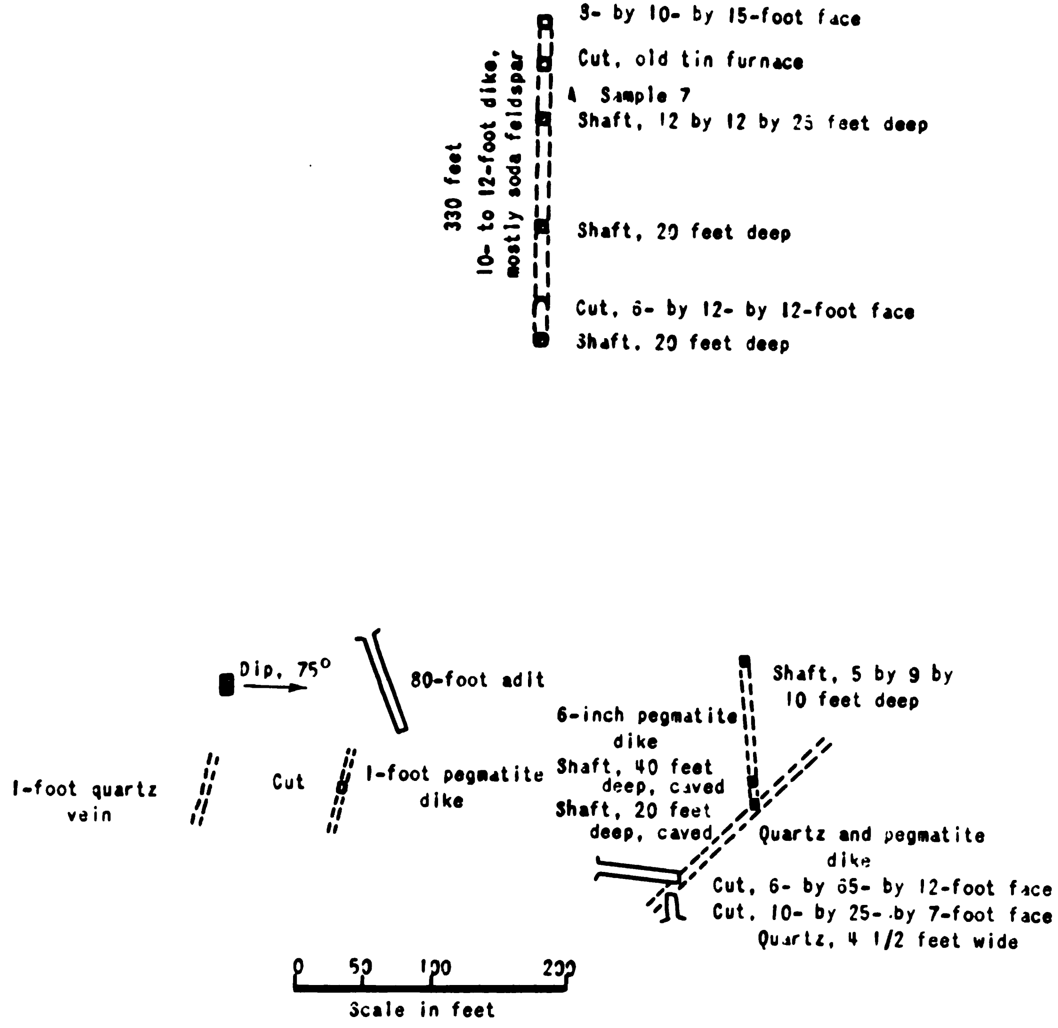
9- by 10- by 15-foot face
Cut, old tin furnace
Sample 7
Shaft, 12 by 12 by 25 feet deep
330 feet
10- to 12-foot dike, mostly soda feldspar
Shaft, 20 feet deep
Cut, 6- by 12- by 12-foot face
Shaft, 20 feet deep
Dip, 75°
80-foot adit
Shaft, 5 by 9 by 10 feet deep
6-inch pegmatite dike
Shaft, 40 feet deep, caved
Shaft, 20 feet deep, caved
1-foot quartz vein
Cut
1-foot pegmatite dike
Quartz and pegmatite dike
Cut, 6- by 65- by 12-foot face
Cut, 10- by 25- by 7-foot face
Quartz, 4 1/2 feet wide
0
50
100
200
Scale in feet

Figure 9.- Plan of Tin Boom veins, Hill City, S. Dak.

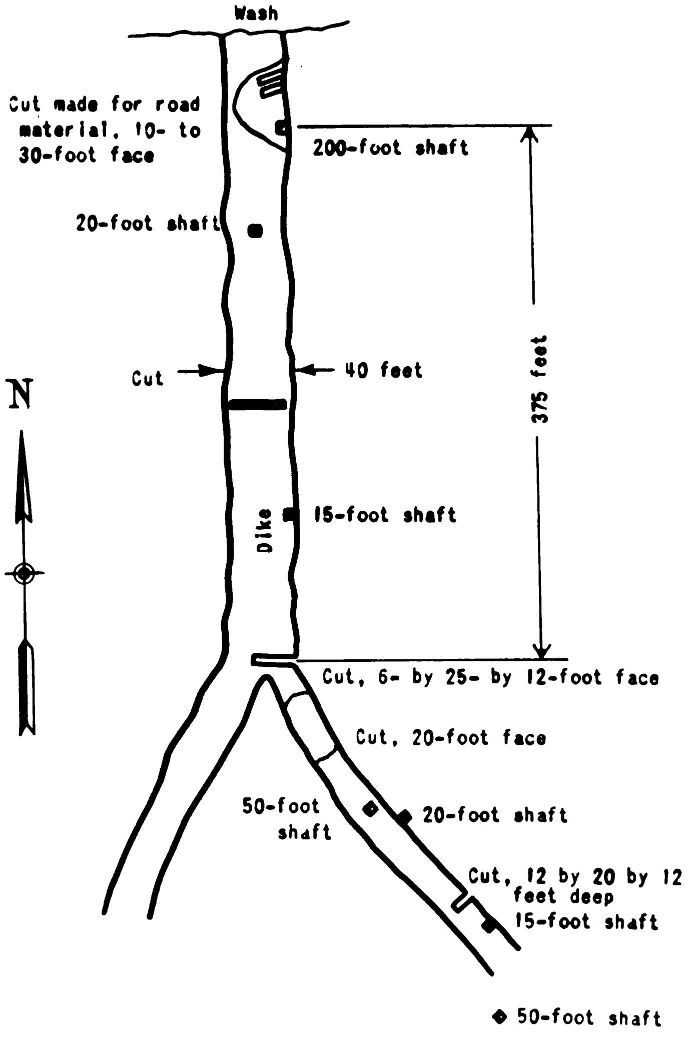

Figure 10.- Plan of Mateen dike.

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in quartz. The ore occurred in a short, small, irregular lens in the dike. A few scattered crystals have also been found in the schist at the edge of the vein. According to Palmer, tin-bearing pegmatite was found in the vein in the drift run to the northwest, but it was not of milling grade. Preparations were made for stoping, but none was done in the drift. The permanent water level is just above the 100-foot level.

As the workings are caved and no records are available, no estimate can be made of the tonnage of ore mined. The grade was probably about 0.5 percent of tin. Possibly several hundred tons has been mined from the claim.

Possibilities of Future Production. - About 350 feet of drifting has been done on the 100-foot level and 150 feet on the 40-foot level. The ore shoot, which outcropped, was stoped from the 40-foot level, but the drifting opened no other shoots. According to Palmer the vein was strong on the 100-foot level.

Available data indicate that no part of the vein disclosed in the workings could be mined at a profit under normal prices for tin.

The 40- and 100-foot shafts are caved, and subsidence has reached the surface. The sides of No. 3 (86-foot) shaft at the end of the vein have sloughed and filled the bottom 36 feet. This shaft probably could be put in working condition cheaper than a new one could be sunk. Probably the drifts are not badly caved.

To reopen the mine a new surface plant would be required. The cost of a hoist and other surface equipment for repairing the shaft and cleaning out the 100-foot level would be about $3,800. Timbering and repairing the shaft would cost about $750. The cost of restoring the drifts would be about $5 per foot. The next step would be to sample the vein at 5-foot intervals, which would cost about $8.50 per sample. Approximately 320 feet of the 100-foot level is on the vein.

If portions of the vein on the 100-foot level were found to be tin bearing and the demand for tin were strong enough, the No. 3 shaft could be eepened or a new shaft sunk from the surface to explore the vein below this evel. Sinking a new shaft would cost about $75 per foot and drifts from it 15 per foot.

Tin Boom

The Tin Boom mine is about three-eights mile northerly from the Mohawk. he property originally was a part of the Harney Peak holdings; it was known s the General Harney claim and was included in a group with the Mohawk. e Tin Boom was held by the National Tin Corporation, which did considerable rifting from the shaft (see fig. 9) but, according to Palmer, with discouraging results. The four or five dikes on the property have been covered y locations of various names at different times since the early days; in ly 1937 the ground was held as the Golden Slipper No. 1 and Golden Slipper . 2 locations by Frank Fortes and I. M. Uppercu.

The ground was inspected July 16, 1938, in company with George W. Coats.

Development work consists of a two-compartment shaft 6 by 12 by 100 feet deep with 1,200 feet of drifts and crosscuts as follows:

Adit, 4 1/2 by 6 by 80 feet long.
Cut, 8- by 10- by 15-foot face.
Shaft, 12 by 12 by 25 feet deep.
Shaft, 6 by 8 by 20 feet deep (caved).
Cut, 6- by 12- by 12-foot face.
Shaft, 6 by 6 by 20 feet deep (caved).
Shaft, 5 by 9 by 10 feet deep (caved).
Shaft, 6 by 6 by 40 feet deep (caved).
Shaft, 20 feet deep (caved).
Stope, about 10 feet long (caved).
Cut, 6- by 65- by 12-foot face.
Cut, 10- by 25- by 7-foot face.

All surface work except the 6- by 65- by 12-foot cut was done by the Harney Peak company. The National Tin Corporation sank the 100-foot shaft in 1920 and, according to Palmer, did 600 feet of drifting and crosscutting. A 350-foot crosscut was driven from the shaft to the large dike. The water level is 60 feet from the collar of the main shaft.

The dikes are relatively short. The largest consists principally of albite, is 12 to 15 feet wide at the surface, and is about 240 feet long; it outcrops prominently. At the 100-foot level, according to Palmer, the dike was 6 feet wide and 150 feet long; it contained some tin on this level but no important quantities. The feldspar at the northern end at the outcrop has some finely divided cassiterite speckled through it at one place; a sample assayed 0.02 percent tin. A few isolated crystals were noted in quartz and associated with mica. A 100-pound boulder consisting mostly of feldspar and mica was embedded in the overburden at the southern end of the dike. A sample of the best-appearing material was assayed and contained 3.30 percent tin. The highest-grade material, both in float and in place, was associated with the pearly mica. Except for some boulders that may have been gathered, apparently no tin has been produced from the dike. Indications are that no part of the dike now in sight could be worked for tin.

To the south of the main dike a quartz and pegmatite dike, 1 1/2 to 4 1/2 feet wide, is joined at an angle by a 6-inch pegmatite dike. Specimens of vein material containing tin were found on each of the dumps of the workings on this dike shown in figure 9; a few scattered crystals were found in place. At the intersection a small stope was taken out in the early days; probably 25 to 50 tons of ore was mined. The vein was up to 18 inches wide in the stope. The large cut at the southern end is recent work; the other openings were made in the early days.

Tin was noted in one small spot in the 1-foot pegmatite dike near the shaft.

Possibilities of Future Production. - The best showing on the large dike at the surface was sampled and assayed; the assay returns showed 0.4 pound of tin to the ton. The other dikes were mostly barren, and the quantity of scattered crystals of cassiterite noted in place was insignificant.

To explore the ground further, the first step would be to unwater the 100-foot level and investigate the large dike cut on that level. Where the vein showed tin it should be sampled.

The 100-foot shaft appeared to be in good shape to the water level. Doubtless it could be put in working shape for a few hundred dollars.

A hoist, pump, skip, and car with hand tools costing about $3,800 would be required before the shaft could be repaired and the level cleaned out.

Samples should be taken at 5-foot intervals across the vein; they would cost about $8.50 each.

Tin Spike (Annie No. 1)

The Tin Spike (formerly Annie No. 1) is an unpatented claim adjoining the Tin Boom on the south and one-half mile west of Hill City. The ground was part of the holdings of the National Tin Corporation from 1916 to 1918. The latest location was made by H. G. Mills and George W. Coats July 15, 1938. t was described as the Annie No. 1 by Hess.[26]

The National Tin Corporation sank a 16-foot shaft and ran an open-cut ith a 7- by 30- by 7-foot face on an 18-inch dike in 1918. Two caved shafts n the south end of the claim are on a 6-foot quartz vein. One shaft is eported to be 40 feet and the other 60 feet deep; they are connected by a rift 105 feet long. The upper shaft has an inclination of 70° to the east.

The 18-inch dike is about 100 feet long, strikes N. 20° W., and dips bout 60° to the east. A small shoot of tin-bearing material is opened in e dike by the cut and shaft made by the National Tin Corporation; it is bout 30 feet long and has a maximum width of 18 inches. About 2 tons of ecomposed pegmatite consisting mostly of quartz and mica is piled on the aft dump; an 8-pound selected sample of the fines from the dump was panned d yielded slightly over 1 ounce of tin concentrate.

Other short outcrops of pegmatite barren of tin can be traced on a line to the Tin Boom. A small draw across the line of outcrops was placerned for tin and a production of several hundred pounds reported.

The quartz vein on the south end of the claim is 6 feet wide at the rface; at 12 feet it narrows to 18 inches and apparently widens out below. ams of mica occur in the quartz on the footwall. From 100 to 200 tons of in matter has been stoped from a small shoot from the 40-foot shaft. Some

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/ Hess, F. L., Tin, Tungsten, and Tantalum Deposits of South Dakota: Geol. Survey Bull. 380, 1909, p. 146.

stoping may have been done from the drift. The vein contains a little wolframite, mostly in the quartz, and a little cassiterite associated with the mica. The vein also contains a little bismuth. According to Mills, the National Tin Corporation produced about 100 pounds of tungsten and a smaller quantity of tin concentrate from this vein. The ground was visited July 31, 1938, in company of H. W. Mills.

Possibilities of Future Production. - The small ore shoot on the 18-inch vein averaged 1 foot wide by 30 feet long and contained about 2 1/2 tons per vertical foot. The 8-pound sample selected from the highest-grade material from the shoot, when panned, contained 1 ounce of black tin (equivalent to 16 pounds per ton). The entire shoot would average about 3 pounds per ton or 7 1/2 pounds per foot of vertical height.

Samilias (New Hope Nos. 1 and 2)

The Samilias prospect comprises two unpatented mining claims that are side by side in sec. 35, T. 15 S., R. 5 E., about 1 mile from the Rapid City-Hill City Highway. The ground has been located from time to time since the early days of tin mining in the Black Hills. It was part of the Harney Peak holdings and is now held (1938) as the New Hope Nos. 1 and 2 by B. A. Hardesty and H. G. Hardesty, who live nearby on their mother's homestead. The Hardestys have been keeping up the assessment work for several years.

Some ore from the vein on New Hope No. 2 was included in the 50-ton shipment to England made by the Harney Peak company, but as far as is known no ore from either claim was milled.

New Hope No. 2. - The development work on New Hope No. 2 comprises a cribbed shaft, 4 1/2 by 10 by 100 feet deep (caved), a shaft 4 1/2 by 10 by 40 feet deep, and a trench 5 by 4 by 20 feet long, done by the Harney Peak company, and a cut with a 7- by 44- by 14-foot face made by the Hardestys, w have also cleaned and repaired the 40-foot shaft. The workings were dewatered to the 40-foot level during the summer of 1937; the hand pump used is still in place.

The country rock is schist similar to that at the Cowboy. The dike is about 115 feet long and 1 to 4 feet wide and dips nearly vertically. It strikes N. 20° E. for 65 feet and thence N. 45° E.

All the workings are in the vein. The cut extends 30 feet to the north end of the vein and thence 14 feet along it; the face is 10 feet from the 100-foot shaft. The 20-foot trench is along the vein between the two shafts The vein widens from 1 to 2 1/2 feet in the 14 feet exposed in the cut. A few feet farther south and for 40 feet the vein is 3 feet wide at the surfac The width of the south 40-foot segment is 1 foot. B. A. Hardesty states th the vein is 4 feet wide at the bottom of the 40-foot shaft and 2 feet wide at the bottom of the 100-foot shaft.

The vein consists principally of quartz with some mica. Most of the cassiterite occurs in the quartz. Tin has been found over a distance of about 65 feet, but the so-called ore shoot is only 36 feet long. Two or three hundred pounds of tin-bearing material is piled on the dump of the cut. Hardesty states that it contains 3 percent tin; the cassiterite crystals are relatively large. Cassiterite was noted in one place in the face. A sample taken from the face by the author assayed 0.02 percent tin.

The dumps from the two shafts are mostly quartz. Part of the quartz contains relatively large crystals of cassiterite up to 1 inch in diameter. About 40 tons of the dump probably contains 1 percent tin; 10 tons could be sorted out that run 2 percent tin. Hardesty claims that one sample of ore in place in the 40-foot shaft assayed 3 percent tin.

An old shaft about 150 feet to the west is on another quartz vein, however no tin has been found in it. It is on the line of strike of the dike previously described.

New Hope No. 1. - The development work consists of a 50- and a 90-foot shaft about 30 feet apart on a quartz lens approximately 50 feet long and up to 3 feet wide. The lens is on a little mound in a flat; it dips 60° to the west and strikes northerly and southerly. The quartz is 3 feet wide at the collar of the south end of the 90-foot shaft but narrows to 1 foot at a depth of 6 feet. At the other end the quartz is 2 1/2 feet wide as far down as can be seen (20 feet); Hardesty states that this width is maintained to the bottom. At the 50-foot shaft the width is 2 1/2 feet at the surface and 1 foot at a depth of 15 feet. About 10 tons of quartz piled on the dumps contains some small crystals of cassiterite; probably the quartz would assay about 0.5 percent tin.

Four pits have been sunk on the line of strike to the north as assessment work. One about 75 feet and another 150 feet away are in quartz, however the quartz contains no tin.

Hardesty states that about one-half mile to the south on open ground on a ridge is another quartz lens as good as that on the New Hope No. 1. It as not inspected.

Possibilities of Future Production. - The part of the vein that contains in is about 36 feet long, averages 2 feet wide, and runs about 6 tons to a oot of depth. Probably 200 to 300 tons of quartz containing 0.5 to 1 perent tin could be sorted out to a depth of 100 feet.

To investigate the New Hope No. 2 for future production the first step ould be to sample the surface exposure and the next to unwater the shafts nd sample the vein where exposed. The workings probably could be unwatered a hand pump, and a hand windlass could be used to clean out the 100-foot haft. This work probably could be done for $150. About 5 samples costing .50 each should be taken at the surface; 20 should be taken from the 100-oot shaft and 8 from the 40-foot shaft at a cost of $11 each; the total mpling cost would be $340.

If the price of tin and the results of sampling should prove satisfactory, hen a surface plant costing about $3,300 could be installed and the 100-foot shaft sunk another 100 feet, or until the quartz pinched out. The cost of sinking 100 feet would be about $7,500.

Sally Cavanaugh

The Sally Cavanaugh property consists of an unpatented claim. As far as could be ascertained the ground was open for location August 2, 1938, at the time of the visit. According to Cummings[27], however, the claim is patented. It was deeded by Mary E. McDermott to Patrick Prendergast, October 12, 1897; no further transfers are recorded. No location notices were found on the ground, and no work has been done for at least 10 years. It is about one-half mile from Oreville.

The development work beginning at the north end comprises:

Shaft, 4 by 4 by 6 feet deep.
Shaft, 4 by 6 by 8 feet deep.
Cut, 6- by 12- by 10-foot face, across lead.
Cut, 6- by 16- by 14-foot face, across lead.
Cut, 15- by 15- by 20-foot face, along lead.
Adit, 4 by 6 by 10 feet long, caved in schist.
Cut, 6- by 50- by 10-foot face, in schist.
Caved adit in face of cut in schist.

The lower cut and adit are below the end of the dike. The adit apparentl was started with the intention of drifting on the lead at a depth of about 75 feet. The cuts on the dike start in the hanging wall.

The dike averages about 15 feet wide, is about 300 feet long, strikes N. 10° C., and dips 70° to the west. It runs along a steep hillside sloping in the same direction as the dip and outcrops boldly for most of the distance. The pegmatite is relatively coarse-grained.

An oval area 4 feet along the strike and 1 1/2 feet high at its widest point in the face of the 15- by 15- by 20-face cut, 10 feet from the top, contains coarse crystals of mica and cassiterite; the lens as exposed probably would assay over 15 percent tin. This is the highest-grade showing of tin found in place by the writer in the Black Hills. However, no other tin was found either in place or on dumps of other workings in the dike.

Another dike outcrops across the canyon about 500 feet distant and boulders of pegmatite occur in the canyon upstream from the Sally Cavanaugh.

As far as is known no tin has been produced from the Sally Cavanaugh. The surface is well-exposed.

The Sally Cavanaugh dike was visited in company with H. G. Mills.

Possibilities of Future Production. - If it were desired to explore the dike the most logical development would be to extend the adit to the dike and then along the footwall, as there is evidence that tin favors the footwall in dikes of the Black Hills. The cost per foot of drifting would be about $12.

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[27] Cummings, J. B., and Lincoln, F. C., Tin Deposits in South Dakota: Published by State Planning Board, Brookings, S. Dak., as a W. P. A. project, June 15, 1936, p. 27.

Tin City (Tin King)

The Tin City claim is about 6 miles south of Hill City at Oreville. It was held during the early days by Frank Herbert who did not sell it to the Harney Peak company; it is reported that he refused an offer of $30,000. The ground is now occupied by D. L. van Ness who states that it was included in a patented 160-acre homestead. Van Ness purchased a tax title to the homestead. According to Cummings the Tin City claim is patented.[28]

The development work on the westerly of two dikes consists of a 6- by 6- by 40-foot trench, a 6- by 6- by 10-foot shaft, and a 4- by 6- by 6-foot shaft. On the easterly dike it comprises a caved incline shaft 7 by 7 by about 70 feet deep and a shaft 7 by 7 by 10 feet deep.

The western dike is 4 to 10 feet wide and about 115 feet long, strikes northeast-southwest, and dips 65° northeast. The other dike, about 350 feet toward the east, strikes northerly and southerly and dips about 30° to the west. In the 10-foot shaft this dike is about 3 feet wide. It appears to be relatively short, but the outcrop is obscured by overburden.

The pegmatite is coarse-grained, and the western dike contains bunches f feldspar up to 100 pounds in weight. Hess[29] states that a shoot about 4 eet in diameter carried considerable cassiterite, which, if present in uantity, undoubtedly would be worth mining. This showing apparently has een dug out; only after a careful search was cassiterite found in any of he fragments on the dump.

The incline on the eastern dike is full of water. A pile of pegmatite eighing about 6 tons on the dump of this shaft contains pieces assaying up o 3 percent tin, but the average for the 6 tons would be less than 1 perent. A few pieces of tin-bearing pegmatite were also noted in the shallow haft. The dike as exposed would not contain 1 pound to the ton.

No tin has been produced from the ground. The dikes were visited August in company with H. G. Mills.

Champion

The Champion pegmatite dike is on the old Hill City-Keystone road about miles from Hill City at Underwood's farm. It was a part of the Harney eak holdings and is held under location by James N. Smith; the ground also as been relocated by other parties. The dike is 700 to 800 feet long, dips ° to the northwest, and is about 5 feet wide. Five or six old cuts and a -foot incline shaft have been dug along the dike. A little tin was noted one place. A cut at the northeast end contains some wolframite.

It was visited August 1, 1938, in company with James N. Smith and H. G. lls.

/ Cummings, J. B., and Lincoln, F. C., work cited in footnote 27, p. 28.
/ Hess, F. L., work cited in footnote 26, p. 141.

Hardesty Homestead

A 4-foot dike with a showing of tin occurs on the S. E. Hardesty Homestead in sec. 36, T. 15, R. 5 E., on the highway between Hill City and Rapid City about 8 miles from Hill City. The dike was covered by a mining claim belonging to Ed. Cleabourn in the early days; it was not sold to the Harney Peak company, and no tin has been produced.

The development work comprises a 60-foot caved shaft and an opencut. Although tin is reported as having been found in the dike, none was seen by the writer. A sample of the dump from the shaft that was assayed showed only a trace of tin. The ground was inspected August 1, 1938, in company with B. A. Hardesty and H. G. Mills, both of Hill City.

Tin Belle

The Tin Belle dike was covered by one or more mining locations in the early days; it is now part of the Penalauna patented homestead, which belongs to D. W. Goodson. The homestead is 3 1/2 miles northeast of Hill City and 3/4 mile from the highway. The dike is 3 feet wide and has been developed by a 75-foot drift. About 50 feet away is a 40-foot drift on an 18-inch parallel dike or spur of the wider one.

Approximately 25 tons of pegmatite on the dump of the 40-foot tunnel contains specimens showing isolated crystals of cassiterite; the dump probably would assay 1 or 2 pounds of tin to the ton. One specimen containing specks of cassiterite was found in a 6-ton pile of pegmatite on the dump of the 75-foot drift.

Wide Dikes

Two wide dikes in the Hill City area, the Mateen and Tin Center, were included in the Harney Peak holdings and developed in a search for tin-bearing material. The Harney Peak company also did some work on the Etta and possibly other wide dikes near Keystone. As stated before, the first discovery of tin in the Black Hills was made at the Etta, and the first mill was built there.

Mateen. - The Mateen is at Hill City about one-half mile southeast of the post office. It was originally part of the Harney Peak holdings and now is reported to belong to the John Kennedy Estate of Philadelphia. The original claim was located in 1883.

It was inspected July 15, 1938, in company with F. C. Lincoln and George E. Flavin of Rapid City and George W. Coats of Hill City.

The development work was done by the Harney Peak company. Beginning at the north end (see fig. 10) the work done is as follows:

Shaft, 10 by 16 by 200 feet deep, caved at 40 feet.
Shaft, 6 by 6 by 20 feet deep.

Original from THE OHIO STATE UNIVERSITY

Shaft, 6 by 6 by 15 feet deep.
Cut, 6- by 25- by 12-foot face.
Cut, 25- by 50- by 20-foot face.
Shaft, 6 by 6 by 20 feet deep.
Cut, 12 by 20 by 12 feet deep.
Shaft, 6 by 6 by 15 feet deep.
Shaft, 6 by 8 by 50 feet deep.

According to Coats, the 200-foot shaft was sunk in 1889 and the last of the development work done 45 years ago (except cut for road material). Most of the dump of this shaft has been hauled away for surfacing dirt roads. A cut, shown on figure 10 but not included in the above, was run on the dike near the shaft for road material.

The country rock on either side of the dike is schist with a slaty tructure. The schist strikes with the dike and dips 35° to the west. The ike extends up the side of the valley for a short distance and then forms a idge for the rest of the way. The lower (north) end apparently extends der surface wash. The lowest part of a western branch at the south end is bout 158 feet below the ridge. The dike strikes northerly and southerly d dips slightly to the east. It is about 40 feet wide and 375 feet long where it splits. (See fig. 10.)

On the whole, the dike is not tin bearing and does not contain definite ones or areas of cassiterite. Although the dike was examined carefully assiterite was observed in place only in a few spots, and there sparingly. t the 15-foot shaft on the south end a small patch of quartz and mica contained a few small crystals of cassiterite. A few scattered crystals were oted at two or three other locations. At one place in the main dike the imensions of a body of tin-bearing material that had been removed were vident. The ore body was 1 foot wide, 6 feet long, and 1 to 2 feet deep. he development work apparently was started on the original tin showings at he surface.

Cassiterite was also found in float and in a few pieces of material at previously had been blasted from the dike.

Some tin boulders and material blasted from the dike were gathered in e early days and milled. Coats states that some of the boulders, which re included in the shipment to London, were very high grade.

The cassiterite in the float was associated principally with a pearly ca; this mica is in larger crystals and is much more abundant than in the dy of the dike.

A few specimens containing tin were found in the remnants of the dump of e 200-foot shaft. The shaft was started on the hanging or east wall; Coats ates that some tin was found on the west footwall at the 100-foot level. e shaft was vertical and cut the footwall at this level. Some drifting s done but no stoping.

Zones of the dike comprise a mixture of spodumene with feldspar and quartz; if amenable to milling, these spodumene bodies apparently are large enough for economical extraction. The spodumene crystals are small and comprise up to 50 percent of the total rock in the zone.

Possibilities of Future Production. - No tin ore of any description is indicated by present showings. The few occurrences of tin found in the dike were small and widely separated. A relatively small production of tin could be expected as a byproduct if the dike were mined for the spodumene. As the dike forms a ridge for most of its distance, a fairly large tonnage could be obtained in an open-cut.

The topography would permit a drift being driven 75 feet below the top of the ridge. Long drill holes from such a drift could be used for sampling the dike at this elevation.

Diamond drilling from the surface would determine whether spodumene exists at depth. The tin bunches are so small and far apart that diamond drilling would not be a suitable method for determining the tin content. As the tin appeared to favor the walls, trenching along both walls might disclose bunches of ore not evident at the surface.

Drifting from the surface would cost about $12 per foot. Longhole hammer drilling from the drift would cost about $1.50 and diamond drilling from the surface, $1.75 per foot.

Beecher Lode. - The Beecher Lode is near Sanator on the highway between Custer and Pringle. The ground is patented and at present is held by a company headed by George Bland. The mine has been worked for feldspar, amblygonite, and mica. It is reported that 25 tons of columbite has been sorted out and shipped from the main pit. The main pegmatite dike is tabular in shape, 300 feet long, and 100 feet wide. An old cut with a 6- by 14- by 6-foot face at the north end of the main open-cut workings has been cleaned out recently. About 2 tons of iron-stained soda feldspar on the dump contains some cassiterite. A grab sample of the dump taken at definite coordinates contained 1. percent tin. Apparently, all tin-bearing feldspar in sight had been dug out of the cut and piled on the dump. No similar-appearing rock is left in the sides or face of the cut; evidently, a small kidney of ore was discovered.

A few scattered crystals of cassiterite were noted at two places in the cut; most of the tin in place was in quartz with a little mica. No tin has been reported from the main workings, and no tin has been produced from the lode. The lode was inspected July 28, 1938, in company with George Bland and John Bland of Hill City and A. C. Bland and Paul Moore of Kansas City,

Tin Center. - The Tin Center, formerly the Liberty Bell, is an unpatented claim at Hill City; H. G. Mills is the present locator. It was a part of the holdings of the Harney Peak company and, later, of the National Tin Corporation. It is about one-half mile from and parallel to the Nateen dike.

The work on the dike was done by the Harney Peak Co. It comprises:

Cut, 12- by 6- by 6-foot face.
Cut, 8- by 14- by 10-foot face.
Cut, 7- by 14- by 11-foot face.
Shaft in face cut on hanging wall, 7 by 4 by 40 feet deep
  (dip 55° to east).
Cut, 5- by 14- by 12-foot face.
Trench, 6 by 6 by 12 feet long.

The workings extend 100 feet along the south or upper end of the dike.

The pegmatite dike or lens is 12 to 30 feet wide and 400 feet long; it is about 20 feet wide for 300 feet of the length. The strike is N. 40° W. and the dip slightly to the east. The top of the dike is about 40 feet above the valley floor. No tin was noted in the first three cuts listed or in the shaft, either in place or in the dumps. After a careful search a few pieces of tin-bearing pegmatite were found in the dump from the trench. The best and virtually the only showing of tin was at the upper or 5- by 14- by 12-foot-face cut. No tin was found in place, but part of a 10-ton pile on the dump contained some cassiterite; probably about 1 ton of mill ore could be sorted from the lot. Mills stated that the tin came from a small lens in 4-foot section next to the hanging wall of the dike at the face of the cut. As far as is known no tin boulders have been shipped from the ground, and there has been no production from the dike. Unlike the Mateen, the Tin Center dike does not contain accessory minerals that may be of value.

Etta. - The Etta was extensively exploited for tin by the Harney Peak company, and a mill was built on the ground. Very little tin, however, has been produced from the mine. It is the largest producer of spodumene in the Black Hills and also yields other pegmatite minerals. A little tin can be seen in place at the contact of the dike with the country rock. In late years o attempt has been made to save the tin.

Peerless. - The Peerless dike is worked for feldspar and other non-etallic minerals. During the summer of 1938 about 500 pounds of clean assiterite was picked out. The tin is associated with mica and occurs in ne zone in albite.

Custer Area. - A large number of dikes near Custer are worked for eldspar. Some contain occasional isolated or scattered crystals of assiterite, but not in economic quantities. A ton of sorted cassiterite-bearing material was shipped in the early days from a dike now included in he Eller farm.

Other Claims

The following claims described by Hess were not visited by the author. ess was in the district in September 1908. His descriptions follow.

> Blue Bird. - The Blue Bird claim is located on a short pegmatite dike 1 1/2 miles south of Hill City on the north side of a small stream flowing into Spring Creek, which is nearly a mile to

the east. The dike is 14 feet wide at the top and dips 65° E. Cassiterite is carried in veinlike portions of the dike, 1 inch to 2 1/2 inches wide, composed of muscovite and quartz with little feldspar. The mica occurs in narrow aggregates up to 1/2 inch wide by 1 1/4 to 1 1/2 inches long, partly perpendicular to the indistinct walls of the veins.

The cassiterite in many places has a tabular form but is largely anhedral,[30] having been crystallized contemporaneously with the other minerals, quartz, mica, and feldspar. Some particles, however, show their crystal form well, and these were probably the first to crystallize from the mass. Here and there crystals, which are probably twinned, are L-shaped. One specimen has legs that form a right angle and are five-sixteenths and one-half inch long by about one-eighth inch thick. The crystal is broken so that its width is unknown.

At a depth of 40 feet the dike is crushed and pinches out through faulting, which has taken place since the solidification of the dike. A few feet of sinking and of drifting to the east have not shown the continuation of the dike.

Olympia. - The Olympia claim, owned by Henry Pettit, is on the south side of the rivulet near which the Blue Bird claim is situated but a quarter of a mile nearer Spring Creek. The basis of the claim is a pegmatite dike 3 feet thick and several hundred feet long, with a dip of 45° to 55° N. 47° W. The dike is rather fine-grained and at one place for a thickness of about 6 inches along the hanging wall contains considerable cassiterite. This portion of the dike is composed mostly of feathery mica and quartz. The mica is in plates an inch or more long by one-sixteenth to three-sixteenths inch wide in overlapping scales radiating in gently curved lines from an axis. The cassiterite is black, partly in tabular forms, reaching three-fourths inch in length by one-eighth inch in thickness and a little more in breadth. Most of it is in rather irregular flat grains following the lines of the mica.

The portion bearing cassiterite has been traced for 75 feet. A similar micaceous zone is seen along the footwall in places but carries less cassiterite. The middle part of the dike seems to contain little tin. No other accessory minerals were noticed.

Tin Plate Group. - On the Tin Plate group of claims, held by James Angus and lying between the Olympia claim and Oreville (6 miles southwest of Hill City), several pegmatites were examined, of which some were similar in structure to the dike on the Olympia and others were coarser. Only a small amount of cassiterite was seen in any of the dikes. None of the pegmatite had been crushed and panned, however, and this treatment frequently will show cassiterite in some quantity where it is scarcely noticeable on the outside of the rock.

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[30] Anhedral - without crystal faces.

Naiad Queen. - The Naiad Queen claim, held by H. A. Albion, is situated on the north side of a valley one-eighth of a mile south of the Sally Cavanaugh claim. The valley is possibly due to a fault. The claim is on a pegmatite dike 5 to 6 feet wide, dipping steeply N. 55° W. It has been followed for about 200 feet. A shallow shaft that has been sunk at one place is said to have contained some good ore, and smaller excavations have been made at several other points. The cassiterite is not so coarse or so conspicuous as on the Sally Cavanaugh claim, and the rock would have to be tested to obtain any adequate idea of its richness.

Louise. - The Louise claim, held by E. C. Hunt, is about a mile southwest of Oreville, on the west side of and several hundred feet above the Burlington Railroad and the wagon road which parallels it. Two pegmatite dikes outcrop on the steep hillside, whose general direction (N. 17° E.) they follow, with pinched places here and there, for more than half a mile toward Oreville. The dikes are about 75 feet apart at the point at which Mr. Hunt was prospecting. The lower dike is 3 to 4 feet thick, with a dip of 55° N. 73° W. Cassiterite is sprinkled through a shoot a foot thick in the middle of the dike. The length of the shoot along the dike was not clear but could not have been many feet.

The upper dike is of coarser structure, is 5 to 6 feet thick, and shows but little cassiterite. It carries glassy, little-weathered spodumene, the largest crystals of which are from 3 to 8 inches thick by several feet long. The mineral includes some quartz and green tourmaline and appears to be in two shoots a few feet wide. Apatite and lithiophilite, the latter coated with its decomposition product, purpurite, also occur in the dike.

At several places prospect holes and shallow shafts were dug by the Harney Peak Tin Mining, Milling & Manufacturing Co., or others, and some cassiterite may be seen in the dikes at these points.

Forest City. - The claim formerly known as the Clara Bell is now called the Forest City. It is (by road) about 6 miles south of Hill City and 1 1/2 miles east of Oreville. The claim is being worked for gold, but at a depth of 250 feet and about 200 feet northeast of the shaft a tin-bearing pegmatite dike 3 feet 8 inches thick, of light color and fine grain, was cut. The cassiterite is in small pieces with black tourmaline particles of equal size and is mostly in the outer 3 or 4 inches of the dike. The cassiterite is difficult to distinguish from the tourmaline, as both are black; the grains are small and of equal luster, and their occurrence together makes the dike appear much richer than it really is. Feldspar is absent or in minute amount in this part of the dike; quartz occurs in granules, generally of small size, filling the spaces between the mica. The mica in the pegmatite is in narrow blades one-eighth to one-fourth inch across, the books of which are thinner than wide and stand at right angles to the wall.

Alfred Daney reported obtaining 1 1/2 percent of tin from samples taken across the dike. The dike is apparently not exposed at the surface, though other and larger pegmatite dikes are close at hand.

This dike is especially interesting from its close relationship to the gold-bearing quartz vein, which is probably 75 feet away. The vein is from 2 inches to 2 feet in thickness and in places is squeezed into lenticular masses like the pegmatite in the Gertie mine. (See fig. 7.) This squeezing suggests that the origin of the vein was similar to that of the pegmatite, and that it was not formed through gradual building up by percolating waters, but was squeezed through the rocks in a pasty mass. Relationship to the pegmatite is further suggested by the occurrence of black tourmaline in the vein. The tourmaline is in needles up to 2 inches long by one-sixteenth inch thick, confined to the outer 2 or 3 inches of the vein. Some muscovite occurs, but apparently only along the cracks in the quartz. Two granite dikes from 2 to 4 inches thick lie beneath and more or less parallel to the vein but follow a zigzag course from nearly a contact to several feet away.

First Find. - About 2 miles east of Oreville is the First Find claim, on which a pegmatite dike carrying cassiterite and columbite crops out boldly along the road, where it forms the southwest side of a small hill and is exposed for a width of 100 feet, though this is probably much more than the width of the dike, owing to the low dip. It is said that the dike can be followed for three-quarters of a mile to the northwest.

A small open-cut has been made in the dike and some ore taken out. The Cassiterite, so far as could be seen, is confined to a shoot a few feet wide and of uncertain extent and direction.

Others. - Other claims in the southern hills were visited but showed either little tin or no features especially different from those of the deposits already described. Probably hundreds of dikes and veins carrying some tin were unvisited owing to lack of time. Among those seen which showed some special features, but are not described, were the Etta claim (which will be described under "Tantalum"), about 1 1/2 miles by road south of Keystone; the Peerless claim, one-half mile nearer Keystone, where cassiterite is found in connection with amblygonite, lithiophilite, columbite, etc.; the Black Metal claims, described under "Tungsten", a mile

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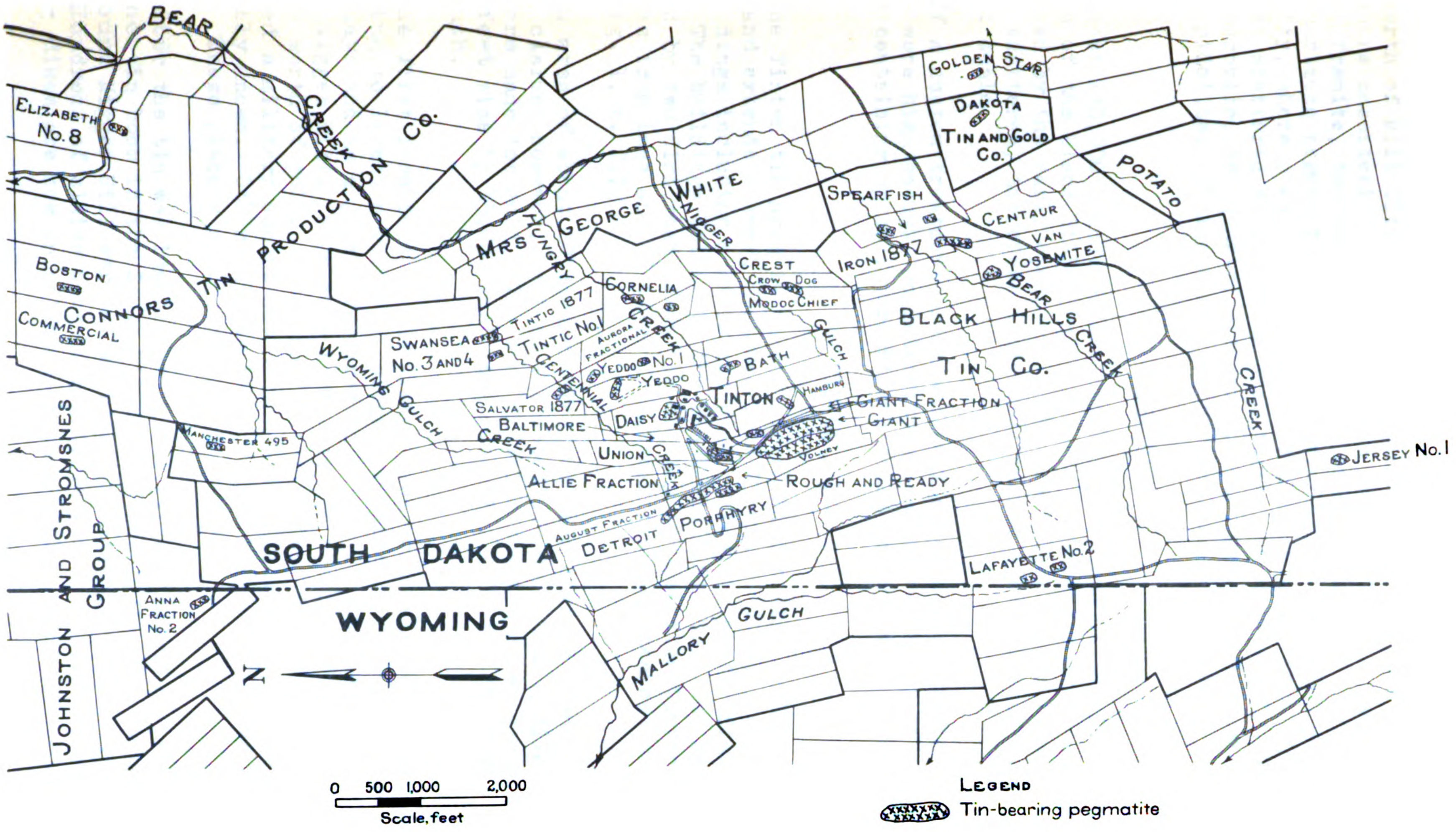

Figure 11.--Claim map of Tinton district, showing location of tin deposits.

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north of Hill City; the Ottumwa claims, 4 miles east of Hill City, where cassiterite occurs in quartz veins with small amounts of wolframite, tourmaline, feldspar, and mica and in a thin dike of quartzose pegmatite; and the Ingersoll claim, 8 miles east of Hill City, where a coarsely crystalline dike 10 to 15 feet thick, carrying scattered fragments of cassiterite, is made up of albite, muscovite, and quartz, with pink, blue, green, and black tourmaline, lepidolite, lithiophilite, purpurite, and columbite.

Summary

About 230,000 pounds of tin has been produced in the Southern Hills section of the Black Hills, and the known tin-bearing dikes were extensively developed by the early operators. The ore bodies so far found are small and widely scattered, therefore individual mining operations are necessarily on a small scale.

If a custom treatment plant was available in the district and the price of tin were high enough, an intermittent daily production of about 50 tons of ore containing up to 1 percent tin could be expected.

TINTON AREA

The Tinton tin area is on and around Nigger Hill in Lawrence County, S. Dak., and extends a short distance into Wyoming. Tinton, consisting of about 15 buildings including a store and post office, is on the flat top of Nigger Hill. The buildings belong to the Black Hills Tin Co. The settlement is reached by two dirt roads from the highway in Spearfish Canyon. It is about 25 miles from Lead and 23 miles from Spearfish, the nearest supply centers. (See fig. 1, p. 2.)

An area of about 20 square miles has been covered almost solidly with mining claims; however, most of the locations more than a mile from Nigger Hill were made for gold. The zone in which the tin dikes occur is about ,000 feet wide by 15,000 feet long (see fig. 11); the long axis is north and south.

The first locations in the Tinton area were made for placer gold. ccording to legend a group of colored prospectors came to Deadwood in the arly days and as a joke were directed to the flat-topped mountain later alled Nigger Hill. They were fortunate and are reported to have washed out 80,000 worth of gold. After making their final clean-up, they asked and btained a military escort out of the Black Hills before their find was enerally known. Other gulches leading from Nigger Hill were then placerined. These placers also contained stream tin.

After the tin was identified in the placer product and coincidental ith the tin boom in the South Hills (1902 and 1903), the pegmatite dikes on nd around Nigger Hill were extensively investigated and prospected for lode in. Hundreds of claims have been patented; with a few exceptions the tinearing dikes are now on patented ground. Only a part of the dikes have been found to contain tin; the work on the others was done mainly as assessment work or to comply with the requirements for patenting.

The principal showings of tin on top of Nigger Hill have been held since the earliest days by the Black Hills Tin Co. and its predecessors in title; however, many claims on which work was done by individuals or companies have been added to the original holdings, which now comprise 2,700 acres of patented claims. The area now held by this company includes most of the tin zone. It is reported that 2 1/2 million dollars has been spent by the Black Hills Tin Co. and its predecessors in acquiring ground, for equipment, and in mining operations in the district.

In addition to the showings on the ground belonging to this company, one tin-bearing dike was examined on ground held by the Dakota Tin & Gold Co. to the southeast, a second on a claim held by A. J. Johnston to the northwest, and another on a claim purported to belong to the Gilt Edge Mining & Milling Co. to the northeast. Two tin-bearing dikes were found on the group of the Connors Tin Production Co. which adjoins the Black Hills tin group on the north.

Geology

The tin in the Tinton area occurs in pegmatite dikes in schist; in two places at the edge of the zone the dikes are in porphyry. Figure 11 shows the locations of the tin-bearing dikes. Many other pegmatite dikes occur in the area, but only those in which tin was found by the writer are shown in the figure.

The pegmatite dikes usually strike with the schist but sometimes cut the formation both in strike and dip. The trend of the main group of tin dikes is southeasterly by northwesterly.

As shown in figures 12 and 13, one or more bodies of pegmatite near the Tinton post office may be considered laccoliths; elsewhere the dikes are relatively narrow, ranging from 1 to 15 feet in width and from 50 to 300 feet in length. The pegmatite is harder than the enclosing schist and usually outcrops, forming ridges or mounds. The dikes swell and contract along the strike, also probably on the dip; they cannot be projected between exposures with any certainty.

The schists are pre-Cambrian and comprise a complex series of mica schists interbedded with amphibolite schists. Large masses of syenite and monzonite porphyry have been intruded into the schists. With the two exceptions where tin-bearing pegmatite dikes were found in syenite and a syenite dike in the Rough and Ready tunnel, the porphyry is not directly associated with the tin-bearing pegmatite. Narrow pyroxenite dikes are parallel to or in the pegmatite dikes at a few places. Hess and Bryan have described the geology of the Nigger Hill area.[31] They describe the pegmatites as follows:

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[31] Hess, F. L., and Bryan, Barnabas, Jr., The Pegmatites at Tinton, S. Dak. Rept. of Investigations 3404, Bureau of Mines, 1938, p. 6.

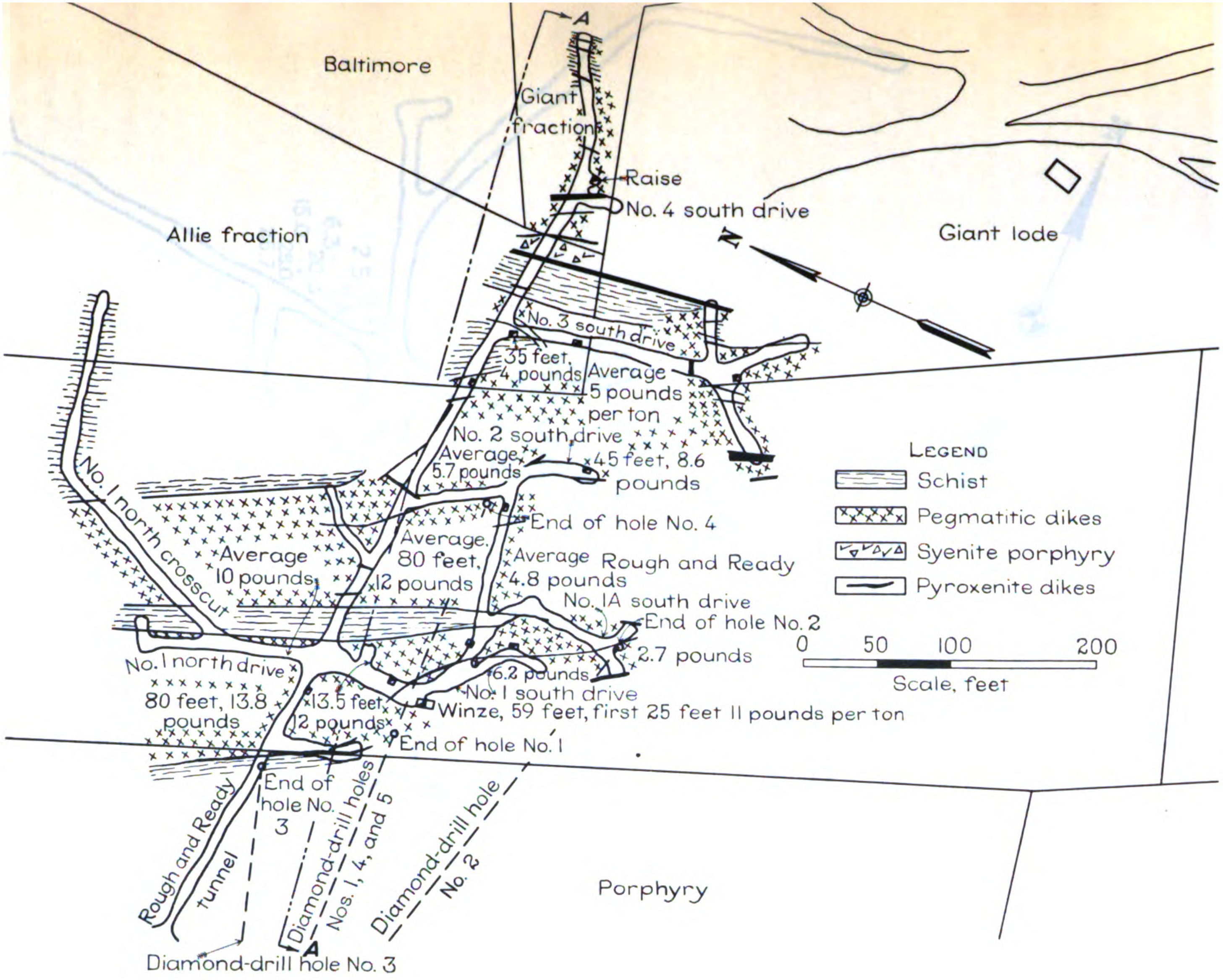

Figure 12.—Geology of tin dikes at Nigger Hill, Tinton, S. Dak. (After A. I. Johnson.)

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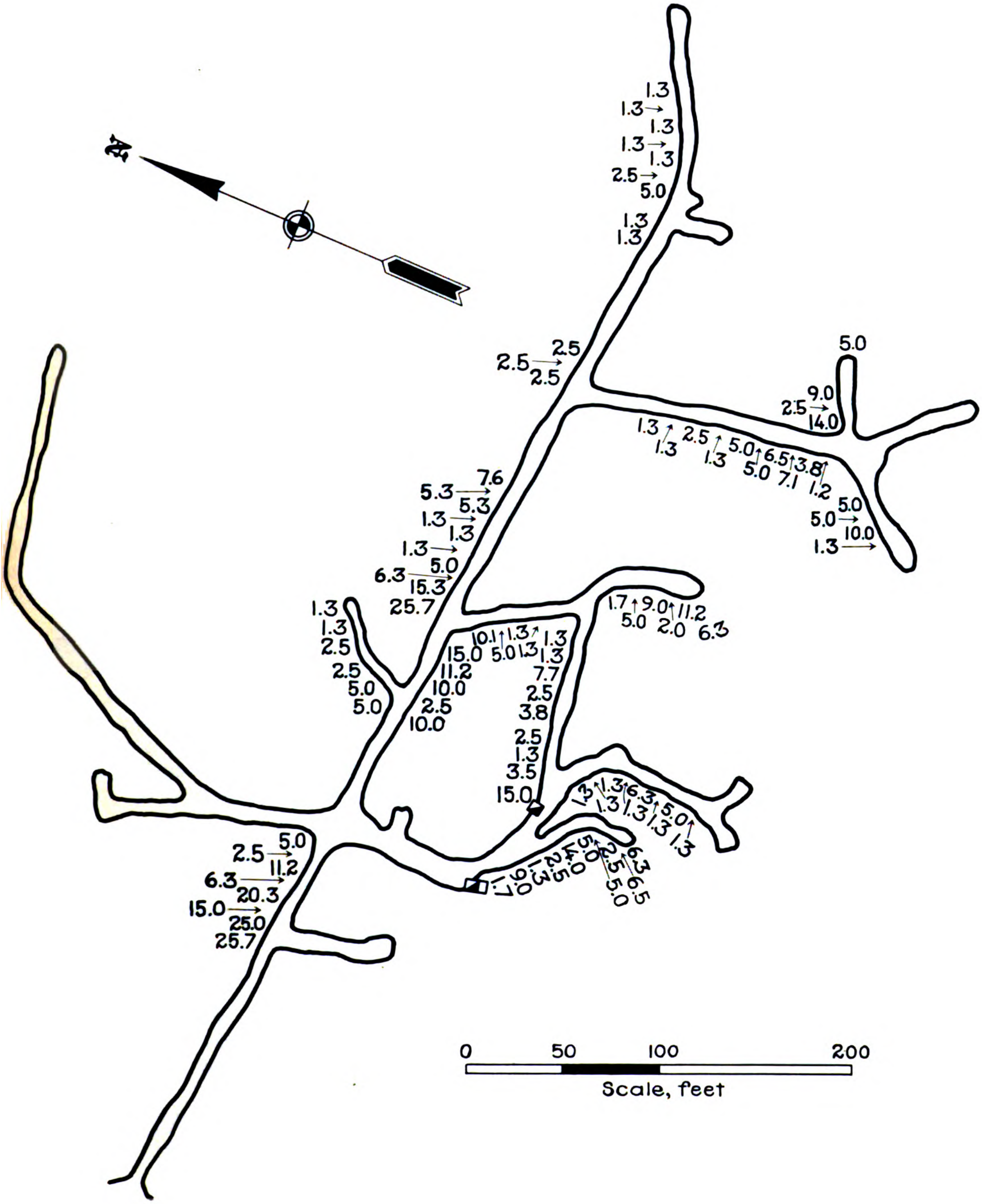

Figure 13.—Assay plan of tin dikes at Nigger Hill, Tinton, S. Dak., pounds per ton. (After A. I. Johnson.)

Most of the pegmatites are sheeted; that is, they are traversed by rather closely spaced parallel cracks. The sheeting apparently is approximately parallel to the schistosity and due to movements in the schist. In those pegmatites that do not lie parallel to the schistosity but occupy cracks running across it, the sheeting cuts across the pegmatite.

Besides the sheeting there are at least three other groups of much less regular cracks - one preceding and two succeeding the sheeting.

Along the group of irregular cracks that preceded the sheeting, albite and other plagioclases and quartz were deposited, though very unequally, in all of the pegmatites under consideration.

Figure 12 shows the geology of the Rough & Ready claim of the Black Hills Tin Co.

Black Hills Tin Co.

It will be noted from figure 10 that most of the tin dikes on the ground of the Black Hills Tin Co. are grouped roughly in a triangular area with a base about 6,000 feet long and an altitude of about one-half mile with an apex at the Rough & Ready claim. The most important tin showing of the company (also in the Black Hills) is on the Rough & Ready. The most important minor dikes are the Spearfish, Centaur, and Yosemite.

The equipment on the ground consists of a 150-ton gravity concentrator with a 90 kv.-a. Diesel-electric engine and camp buildings. A part of the mill has been remodeled to treat tantalum ore. Power is now supplied to this unit by a gasoline engine; it was previously operated by direct-current motors from a steam-driven generator. A hoist and other equipment are used at the tantalum deposit being worked, and similar equipment is used on the lode being developed for gold.

The tin showings on the property were inspected in July 1938 in company with Arthur L. Johnson, consulting engineer to the company, and Earl C. Schultz, mine superintendent for the Fansteel Mining Corporation. Ross J. Beatty, Jr., 1 North La Salle Street, Chicago, is the company agent.

Rough & Ready

Virtually the entire lode production of tin in the Tinton area has come from the Rough & Ready claim, therefore a large part of the underground development has been concentrated on this claim.

Production. - Arthur I. Johnson, in a report to the company dated March 1938, gives the production of ore and tin from the Rough & Ready as follows:

Year	Ore, tons	Tin, pounds per ton ore	Tin recovered, pounds per ton	Tin in ore milled, pounds	Sales, pounds
1903	5,700	14.1	8.46	80,370	----------
1904	1,483	18.8	11.65	27,880	----------
1909	7,147	6.9	----------	49,314	----------
Total or average	14,330	10.995	---------	157,564	104,987
Value .	------	-----------	----------	---------	$27,371.15

Development and Mining. - The development on the Rough & Ready (see figs. 12, 13, and 14) consists of a 570-foot crosscut adit with 590 feet of crosscuts and 815 feet of drifts. A 59-foot winze with a 40-foot drift at the bottom has been sunk from the adit level. A 155-foot shaft with a 128-foot sublevel, 28 feet below the level of the present adit, was sunk from the top of the hill. Figure 14 shows a cross section of glory-hole workings from which past production has come. In addition a large open-cut comprising several thousand cubic yards has been run in front of the adit to reach the dike. This was done as part of a plan to work the deposit by an open-cut method.

The location and spacing of the stope chutes in the glory holes are shown on figure 12. No data are available on mining details or costs. From an inspection of the glory holes at the surface, further production from these workings would appear impracticable unless the overburden was stripped at the edges of most of the glory holes. The remaining ore above the adit probably could be recovered most economically by underground methods.

On a basis of 150 tons per day a standard shrinkage method of stoping probably would be used for mining the Rough & Ready deposit.

Further study would be required to suggest a method or estimate the costs of mining on a larger scale. A modified shrinkage method, such as that used at the Beatson mine at Latouche, Alaska,32/ or at the Alaska Juneau, Juneau, Alaska, might prove practicable.

Milling. - Figure 15 shows the flow sheet of the present mill. The mill is now out of repair. Johnson states that the present water supply limits the capacity of the mill to 150 tons per day.

He estimates that approximately $6,000 would be required to repair the mill and an additional $1,000 for Diesel-engine repairs. The power requirement for the plant is near the maximum capacity of the generating unit.

32/ Presley, Bevan, The Latouche System of Mining as Developed at the Beatson Mine, Kennecott Copper Corporation, Latouche, Alaska: Am. Inst. Min. and Met. Eng., Tech. Pub. 20, 1927, 42 pp.

33/ Bradley, P. R., Mining Methods and Costs, Alaska Juneau Gold Mining Co., Juneau, Alaska: Inf. Circ. 6186, Bureau of Mines, 1929, 18 pp.

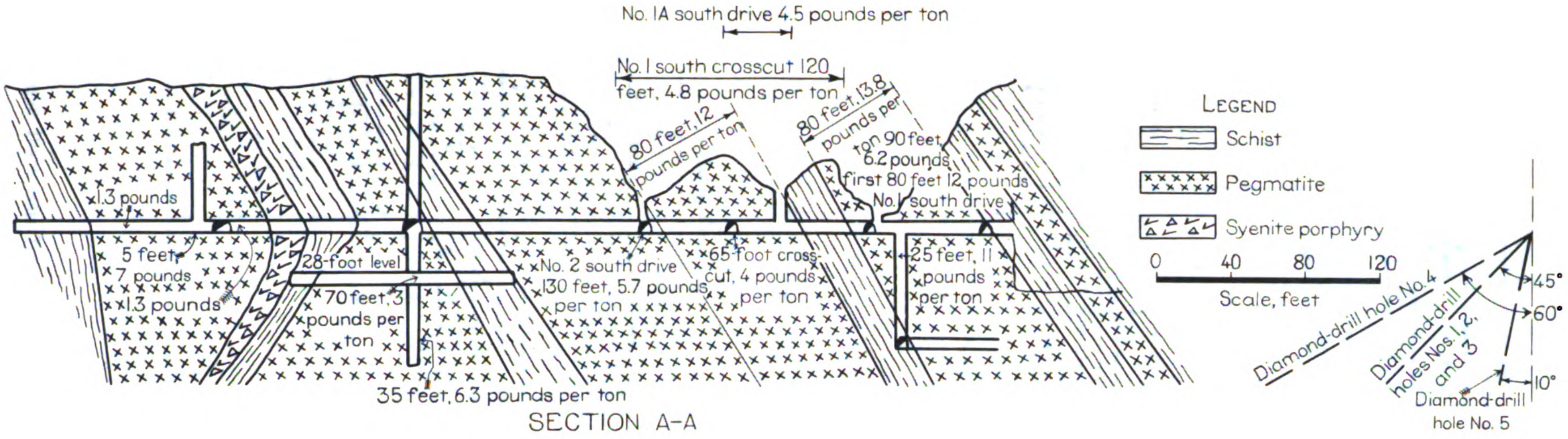
No. 1A south drive 4.5 pounds per ton
No. 1 south crosscut 120 feet, 4.8 pounds per ton
80 feet, 12 pounds per ton
80 feet, 13.8 pounds per ton 90 feet, 6.2 pounds
first 80 feet 12 pounds
No. 1 south drive
1.3 pounds
5 feet, 7 pounds
1.3 pounds
28-foot level
70 feet, 3 pounds per ton
No. 2 south drive 130 feet, 5.7 pounds per ton
65-foot crosscut, 4 pounds per ton
25 feet, 11 pounds per ton
35 feet, 6.3 pounds per ton
SECTION A-A
LEGEND
Schist
Pegmatite
Syenite porphyry
0
40
80
120
Scale, feet
Diamond-drill hole No. 4
Diamond-drill holes Nos. 1, 2, and 3
Diamond-drill hole No. 5
45°
60°
10°

Figure 14.—Cross section of tin dikes at Nigger Hill, Tinton, S. Dak., showing geology. (After A. I. Johnson.)

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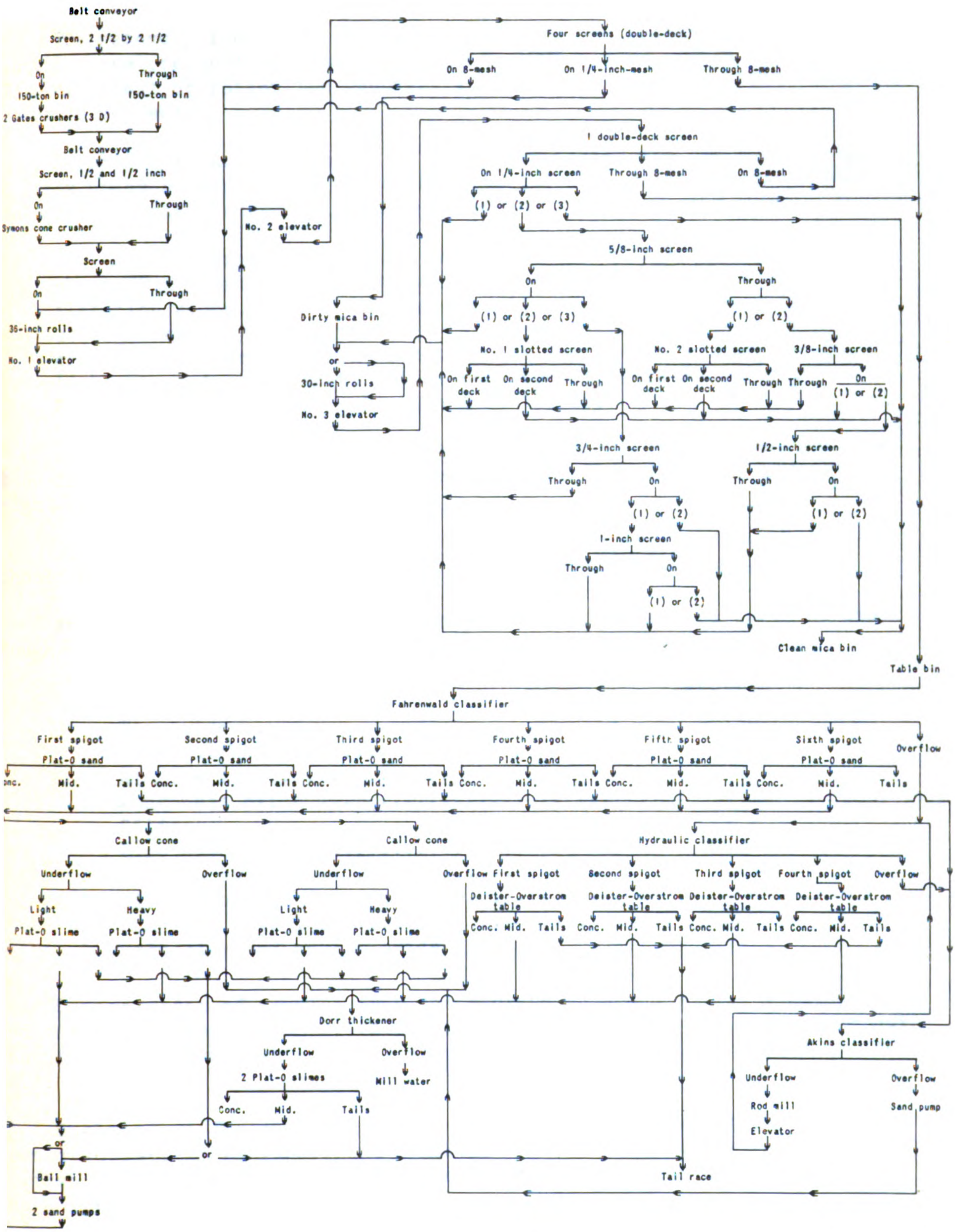

Figure 15.—Flow sheet of mill, Black Hills Tin Co., Tinton, S. Dak., September 23, 1938.

The recovery from early milling operations, as indicated in the table showing mine production, was 60 percent in 1903 and 62 percent in 1908. With efficient operation the recovery in the present mill probably would be about 70 percent.

According to A. I. Johnson, A. M. Gaudin tested the ore from the Rough & Ready under a cooperative agreement with the University of Utah. Gaudin, in a report dated December 18, 1928, made the following statement:

> A concentrate as high as 50 percent tin with a recovery of about 75 percent should be possible in concentrating this ore by flotation alone. About the same results could be expected from straight gravity concentration. A concentration scheme involving gravity concentration and flotation has been found to yield a 60- to 65-percent concentrate with a recovery of about 80 percent. Such an ore treatment would appear justified.

New reagents have been developed, and the technique of flotation has been improved during the past 10 years. The results obtained by Gaudin might be improved.

If the Rough & Ready ore proves amenable to flotation this process should be considered in any plan for extended future operations.

An analysis of the composite concentrate of 56 samples taken on the Rough & Ready in 1904 by Dunraven Young gave the following results:

	Percent
Tin oxide	66.36
Iron sulphide	7.97
Alumina	9.49
Manganese oxide	.89
Silica	6.70
Zinc oxide	1.41
Calcium oxide	1.35
Niobium and tantalum oxide	3.00
Tungstic acid	Trace
Potassium and sodium oxide	1.4

Concentrates of samples from the section adjacent to No. 4 south drive and the raise east of the drive indicate 3 percent columbite and 4 percent tantalite. One knife-blade seam of pyrite was noted by the writer in the adit.

Smelting. - The smelting of tin concentrates in the United States has been discussed by Alexander and Stack.[34] At the time their article was written the Boliva was the only source of tin concentrates for smelting in the United States. They state:

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[34] Alexander, H. H., and Stack, J. R., The Reduction and Refining of Tin in the United States: Trans. Am. Inst. Min. and Met. Eng., vol. 70, 1924, pp. 404-446.

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Payment for Tin. - Usually 96 to 98 percent of the tin contents are accounted for, depending on the kind of ore; in some cases payment for all tin is made, the smelting losses, etc. being taken care of in the treatment charge. The value of the tin is usually determined by taking the average of the prices ruling on the London Metal Exchange for Spot and Three Months Standard Tin, as quoted during the second calendar month after shipment is made. This means that if a shipment is made on January 14, the liquidation would be made as per the average of the quotations for the month of march.

Treatment Charge. - The returning charge and final settlement for the ore is made in pounds sterling. The rate of exchange in recent years has been an important factor in governing the net returning charge; therefore, to offset fluctuations in the rate of exchange and to stabilize the returning charge, the value of the pound sterling may be fixed for the duration of the contract.

Premiums and Penalties. - The concentrates are nearly all purchased on a 60-percent tin basis; for each unit or fraction thereof above or below 60 percent the returning charge is reduced or increased at the rate of 5 s. per unit. The net returning charge has varied from £10 to £25. The basic price for standard tin is generally taken at £170 per ton and the returning charge is increased or decreased at a fixed rate for each pound sterling that the settlement quotation is above or below £170. One percent of sulphur is allowed free and is penalized at the rate of 10 s. per unit or fraction thereof over 1 percent. All transactions are based on a ton of 2,240 lb.

Iron. - Five percent of iron is allowed free and is penalized at the rate of 10 s. per unit or fraction thereof over 5 percent. The usual splitting limits on assays are as follows: Tin 0.5 percent, sulfur 0.2 percent, iron 0.2 percent.

The undesirable constituents such as lead, copper, arsenic, antimony, and bismuth are not penalized specifically, but an increased treatment charge is made to cover costs occasioned.

Freight tariffs usually are considerably less per ton for ore than for metals. As the markets for tin are in the East there would be little object in building a smelter at the mine.

In the past tin concentrate from the Black Hills has been shipped to the Perth Amboy (N. J.) plant of the American Smelting & Refining Co.

Estimated Costs. - Johnson estimates the cost of placing the mine on a 150-ton operating basis as follows:

Drills and auxiliary equipment	$1,800
One 450-cubic foot Diesel-engine compressor to supply air for mine operations	4,500
Hoist, head frame, etc.	2,000
Mine workings, ore raises, etc.	1,500
Total	9,800

The cost of mining (author's estimate) by a standard shrinkage method nd milling 150 tons per day at the old plant would be about as follows:

	Cost per ton
Mining	$1.65
Trucking	.15
Milling	1.50
Overhead and general[1]	.30
Smelting and freight on concentrates (Johnson's figure)	.27
Total	[2] 3.87

[1] Not including amortization or Federal taxes.
[2] Approximately $4.00 per ton.

Building a larger mill would not be justified on the basis of present nown ore reserves; the costs for a larger daily output are given for comparison in the event that large reserves are developed at depth. A rough estimate of the costs of mining by a modified shrinkage method with an efficient underground lay-out and milling in a properly constructed new plant on a 500-ton-per-day basis would be as follows:

	Cost per ton
Mining	$1.15
Milling	.85
Overhead and general[1]	.20
Smelting and freight on concentrates	.27
Total	[2] 2.47

[1] Not including amortization or Federal taxes.
[2] Approximately $2.50 per ton.

The estimated cost per pound of producing tin in an ore that contains 7.5 pounds per ton, on a 150-ton daily basis and with a recovery of 70 perent, would be as follows:

	Cost per pound of tin
Mining	$0.34
Milling	.29
Overhead and general	.06
Smelting and freight (Johnson's figure)	.05
Amortization of new investment ($16,800 over 8 years at 6 percent, 300 days yearly)	.09
Federal taxes and profit	.20
Total	1.03

The estimated cost per pound of tin for the same grade of ore and the ame recovery, on a 500-ton-per-day basis, would be:

	Cost per pound of tin
Mining	$0.22
Milling	.16
Overhead and general	.04
Smelting and freight	.05
Amortization of new mining and milling plant ($1,000,000 over 10 years at 6 percent	.17
Federal taxes and profit	.12
Total	0.76

Ore Reserves. - Figure 13 shows an assay plan of the Rough & Ready workings prepared by Johnson from a report made on the property by A. E. Thomas in 1914. The usual sample interval was 10 feet, and the weight of samples ranged from 500 pounds to 1 ton. After breaking, each sample was quartered down to 50 pounds and then crushed. The 50-pound sample was then quartered by Thomas and the final product "vanned" or panned. The results shown on the assay plan are "black tin" or tin oxide. The percentage, as indicated by the weight of the concentrate, was considered to correspond to the expected mill recovery of white tin. The concentrates from all samples indicating 10 pounds or more of black tin per short ton were collected and assayed; the assay results showed that the concentrates contained 68.4 percent metallic tin. Several individual samples of concentrates were also assay although some of them varied considerably the average results show fair conformity. Four men were required for one shift to take a 10-foot sample; hand work only was employed.

Johnson considers that the material lost in panning would about equal the difference in the percentage of metal in black and white tin.

Johnson has calculated the partly outlined ore reserves to be as follows

Ore reserves Rough & Ready mine, partly developed

Block	Width, feet	Length, feet	Feet sampled	Ore, short tons			Tin	
				Above adit level	50 feet below adit level	Total	Pounds per ton	Total
No. 1 footwall to No. 1 drive	60	200	258.5	14,000	48,000	62,000	9.0	558,000
No. 2-No. 1 to No. 2 drive ..	80	200	395.0	22,400	64,000	86,400	6.4	552,960
Total or average ..	----	----	-----	36,400	112,000	148,400	7.5	1,110,960
No. 3-No. 2 to No. 3 drive ..	80	200	390.0	------	-------	154,000	4.1	-------
No. 4 dike, end Rough & Ready crosscut	125	----	150.0	------	-------	-------	2.2	--------

According to Johnson's assumptions and calculations the expected tonnage for each foot of vertical depth would be:

Block	Ore per foot, tons	Tin per foot, pounds
1 ...	9,600	86,400
2 ...	12,800	81,920
3 ...	12,800	52,480

Johnson summarizes previous estimates of ore reserves of the Rough & Ready mine as follows:

Summary of previous estimates ore reserves, Rough & Ready mine

Engineer	Date	Estimated tonnage	Tin, pounds per ton	Width, feet	Length, feet	Depth below tunnel, feet
Dr. Carmichael, Mass. Inst. Tech	1903	---	13.6	104	---	---
Dr. Carpenter, Dakota School of Mines	1904	---	15.0	---	---	---
r. D. Young	1/1904	78,000	18.8	104	---	50
aul de Rilly	1904	---	13.8	104	---	---
. B. Kennedy	1904	---	15.0	---	---	---
. N. Spicer	1910	---	15.00	---	---	---
. E. Thomas	1913	2/96,000	6.2	255	240	---
. V. Bland	1928	196,335	11.2	---	---	25

/ Estimates 1,400,000 tons probably ore from Rough & Ready to Volney No. 2; distance 2,100 feet to a depth of 50 feet below tunnel over a width of 104 feet.

/ Per 100 feet of depth; estimates 20,000 tons remaining in open-cuts at 13.5 pounds per ton.

Although Thomas used a 10-foot interval for his samples, variations occurred when the distance to be sampled was less. As his report was not available while this paper was being written, Johnson's calculations of average grades could not be checked.

Except for a relatively small tonnage between the adit level and the bottom of the old glory-hole stopes, no ore can be considered as actually blocked out in the mine. It is reported that the sublevel from the drift is in a fair grade of tin ore.

A series of five diamond drill holes, shown on figures 12 and 14, were put down in 1927. The holes were logged by G. V. Bland.

Hole 4, which was drilled at an angle of 45° from the vertical, intersected 30 feet of pegmatite at 266 to 296 feet, or 115 feet vertically below the adit level provided there were no deviations of the hole. Pegmatite was found between 392 and 408 feet (16 feet) and between 475 and 478.6 feet (3.6 feet). The hole was 554 feet deep, but the core from 546 to 554 feet is missing. According to John Bland, the 30-foot dike of pegmatite probably would contain 20 pounds of tin per ton.

Hole 1 was drilled 445 feet deep at an angle of 60° from the vertical in the same plane as hole 4. Fifteen feet of pegmatite was cut 78 to 93 feet down. The log shows that the first 5 feet of this pegmatite contained some tin, and not much core was recovered. The lower 10 feet contained no tin but considerable pyrite. At 244 to 245.5 feet the log shows 1.5 feet of pegmatite with tourmaline, 8 inches of trap rock, and then 18 inches of pegmatite with much tin. Between 354 and 365 feet a 6- and an 18-inch layer of pegmatite were cut; neither contained tin or mica. The hole from 375 to 397 feet (22 feet) was in pegmatite, but the cores contained no tin. From 408 to 445 feet (37 feet) the bottom of the hole was in pegmatite. According to the log this lower pegmatite was high in mica; the core of the last 2 feet contained 70 percent mica. No notation was made that it contained tin.

Hole 5 was in the same plane as holes 4 and 1; it was drilled 10° from the vertical to a depth of 410 feet. A 4.5-foot pegmatite dike containing very little mica, considerable pyrite, and traces of tantalite, was cut between 77.5 and 82 feet. The next foot was breccia with a felsitic ground mass, then there was another 1.5 feet of pegmatite with considerable pyrite. No pegmatite was encountered in the rest of the hole.

Hole 2 was drilled at an angle of 45° from the vertical to a depth of 14 feet. Pegmatite with a 2-foot dike of trap rock was cut between 276 and 287 feet (10 feet); next was 5 feet (287 to 292) of broken schist, 3 feet of pegmatite, 2 feet of trap rock, 12 feet (297 to 309) of pegmatite, 2 feet of schist, and 4 feet of pegmatite. The log states that a little pepper tin occurred from 306 to 307 feet. One foot of pegmatite was cut between 363 and 364 feet and 7 feet from 331 to 338 feet. From this point to the bottom, no pegmatite was encountered. The only mention of tin was at 306 to 307 feet.

Hole 3 was drilled at an angle of 45° from the vertical to a depth of 33 feet. Two feet of broken-up pegmatite was cut between 285.5 and 287.5

feet, 3 feet of pegmatite with some mica from 323 to 326 feet, a 17-foot dike of broken-up pegmatite with considerable mica between 327 and 344 feet, and another 2 1/2 feet of the same material from 344.5 to 347 feet. No cores containing tin are mentioned in the log.

Hole 4 indicates that the 80 feet of pegmatite shown in figure 13 at the outer portion of the adit has decreased to 30 feet at 115 feet and to 5 feet at 172 feet vertically below the adit level. The decreasing width of the principal tin-bearing pegmatite dike and the increasing proportion of schist, as shown by the drill holes, indicate that the ore zones decrease in size at relatively shallow depths, although pegmatites characteristically continue to great depths.

As noted in the table showing the production from the mine, the ore mined in 1909 contained 6.9 pounds per ton. If dilution in mining is considered this figure would check fairly well with Johnson's average of 7.5 pounds for blocks 1 and 2. It will also be noted that the ore mined in 1903 and 1904, which came from nearer the surface was of considerably higher grade.

Possibilities of Future Production. - The estimated cost of producing tin, using the present 150-ton mill, is $1.03 per pound; as shown in table 1 the yearly price of tin ranged from $0.22 in 1922 to $0.87 in 1918.

Johnson estimates that 14,000 tons of ore above the adit level will contain 9.0 pounds of tin per ton and that 36,400 tons (including the 14,000 tons) will average 7.5 pounds; 14,000 tons would supply the 150-ton mill for about 4 months and 36,400 tons for 9 months. The total "probable" ore in blocks 1 and 2 that averages 7.5 pounds per ton would supply the mill for 3 years. If the sampling is correct and the price of tin high enough, sufficient ore could be considered as being developed at the mine to warrant starting the present 150-ton mill.

The cost per ton of producing ore depends partly upon the scale of operations and the adequacy of the equipment. Before plans are made at the Rough & Ready for a larger daily production more development work is needed to prove the ore reserves. Before work is started, however, the sampling done by Thomas should be checked and the true tin content of the ore determined.

A complete sampling job would be needed. As stated before, samples in crosscuts should be parallel to the headings and in drifts across the backs at right angles to the strike. The number of samples to be taken would be as follows:

Rough & Ready crosscut adit:

First dike	7		
Second dike	17		
Third dike	2		
Fourth dike	11		
No. 1 north crosscut	9		
Crosscut from No. 2 south drive	8		
Crosscut, No. 3 drive	10	64	69
Sublevel from winze 50 feet long		5	

Drift samples at 5-foot intervals:

No. 1 north drive	23		
No. 1 south drive	57		
No. 2 south drive	26		
No. 3 south drive	39	145	
Winze - 50 feet deep		10	155
Surface: The dikes are partly exposed in the old glory holes			
Crosscut samples			50
Total			274

Because of the importance of the sampling results at least 100 pounds hould be taken per foot of sample. As a large number of samples would be aken the use of drilling machines to cut the samples or drill holes for lasting would be economical.

The preliminary expense would be:

leaning up workings	$100
ir pipe, 700 feet at 20 cents per foot	140
ipe fittings	20
and tools and other mining supplies	100
earranging machinery in old mill to crush concentrate samples	300
Total	660

The sampling crew would comprise:

samplers at $5.00	$10.00
blacksmith and utility man	5.00
sample handlers at $4.50	9.00
concentrator man	7.50
engineer in charge	10.00
Total labor per day	41.50

The daily expenses other than labor would be:

nt of portable compressor at $75 per month	$3.00
wer in mill	2.00
nt of two drills with steel at $1.50	3.00
soline for compressor	2.50
her supplies	1.00
Total	11.50

It is considered that one sampler with an air drill would break one -foot sample in crosscuts or two 5-foot samples in drifts per day.

The cost per sample of the 10-foot samples (two per day) would be:

Labor:

Sampler	$5.00	
Sample handler	4.50	
One-half concentrator man	3.75	
One-half utility man	2.50	$15.75
Supervision (2 samplers)		5.00
Explosive		.75
Daily expense other than labor		5.75
Preliminary expenses - prorated on basis of 69 large and 205 small samples (cost of large twice that of small)		3.83
Assaying concentrate and tails, 2 samples at $2.00		4.00
Total		35.08

The cost per sample of the 5-foot samples (four per day) would be:

Labor:

Sampler	$2.50	
Sample handler	2.25	
Concentrator men - 2 for 4 samples	3.75	
Utility man	1.25	$9.75
Supervision		2.50
Explosive		.40
Daily expense other than labor		2.90
Preliminary expense		1.93
Assaying		4.00
Total		21.48

In round numbers, the crosscut samples would cost $35 or $3.50 per foot of crosscut and the drift samples, $22 each or $4.40 per foot of drift.

The total cost of sampling would be:

29 crosscut samples at $35.08	$2,420.52
205 drift samples at $21.48	4,403.40
Total	1/ 6,823.92

1/ About $7,000.

After the deposits in the workings are sampled, the next step would be to ascertain definitely the size of the dikes on lower levels and their tin content. Diamond drilling would be useful for outlining the structure, but because of the spotty nature of the ore core samples may give misleading information as to grade. Even if the results of the early diamond drilling are discouraging, more holes should be put down to check the results and obtain new information.

From figures 12, 13, and 14 it would appear advisable to set up a diamond drill in the open-cut in front of the portal of the adit at the hanging wall of the upper narrow body of pegmatite shown in figure 12 and to drill a series of three holes in a nearly vertical plane and another series of three holes to the east in a plane at an angle of about 45° from the horizontal.

These six holes should give useful information regarding the continuation in depth of the part of the dike included in Block 1 (see tabulation of "ore reserves" p. 54). The downward continuation of block 2 could be ascertained by diamond drilling from the sublevel from the winze. Three holes should be placed toward the east in a plane at an angle of about 15° below the horizontal and three more in a plane at an angle of 45° from the horizontal. Doubtless the information gained from this drilling would prompt the drilling of other holes.

The cost of diamond drilling from the surface would be about $1.75 per foot and in the sublevel, $2.25. The holes would be relatively short, and a station would have to be cut in the sublevel.

If the results of the drilling were favorable, consideration should then be given to sinking a prospect shaft. The location of the shaft would be governed by the results of the diamond drilling.

One of the first steps would be to have a mill test of the ore made by a competent metallurgist in a properly equipped laboratory to ascertain whether the ore could be treated successfully by flotation. The expected increase in extraction by flotation over that by gravity methods should be remembered.

Giant-Volney

The Volney adjoins the Rough & Ready on the south and the Giant on the west.

The longest body of pegmatite in the area, called Tantalum Hill, is on hese two claims. In July 1938 the deposit was being worked for tantalum; he operations have been described by Johnson.[35] Some cassiterite was aved in the mill as a byproduct.

The principal development on the claim consists of Volney No. 1 cross-ut tunnel 230 feet long, Volney No. 2 crosscut tunnel 90 feet long, a trench 20 feet long, and an open-cut 15 by 50 feet along the dike with an 8- by 0-foot approach. In addition, a 60-foot drift and 155 feet of crosscuts nd open-cut stopes have been run on the tantalum showing.

The No. 1 tunnel and trench extend into the Giant claim. The two unnels are 450 feet apart and have been run in the pegmatite; the first, olney No. 1, starts in the pegmatite near the west contact or hanging wall nd Volney No. 2 (called Giant by Thomas) at the contact. These two tunnels ere sampled by Thomas.

His results are those from "vanning" assays and are expressed in pounds f black tin per ton (2,000 pounds) of ore. The black tin is considered to ontain 68.4 percent metal. Doubtless all tantalite and columbite that might ave been present were included in the results as black tin. The ore was

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[35] Johnson, A. I., Tantalum From the Black Hills: Eng. and Min. Jour., November 1938.

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crushed and washed; the heavy minerals were separated by panning and weighed. The data in the following table are taken from his report.

Place:	Width taken, feet	Black tin, pounds per t
Tunnel on Volney nearest Rough & Ready:		
(Volney No. 1) entrance to 9 feet in, then 3-foot trap	9	10.1
12 to 20 feet from entrance	8	1.3
20 to 30 feet from entrance	10	2.5
30 feet to porphyry dike	9	1.3
10 feet east side dike	10	1.3
Tunnel on Giant claim (Volney No. 2):		
20 to 30 feet from entrance	10	7.7
30 to 40 feet from entrance	10	16.4
40 to 50 feet from entrance	10	6.3
50 to 60 feet from entrance	10	8.9
60 to 70 feet from entrance	10	2.5
70- to 77-foot face	7	5.0

It will be noted that in No. 1 tunnel 9 feet contains 10.1 pounds and the 39 feet to the dike 3.1 pounds per ton.

The average grades over various widths in No. 2 tunnel, as shown by the sampling, are:

	Pounds per ton
10 feet, 30 to 40 feet from portal	16.4
40 feet, 20 to 60 feet from portal	9.8
57 feet, 20 to 77 feet from portal	8.2

Johnson states:

> Developments on the 60-foot level of the Tantalum Hill shaft have exposed a continuation, for the full length of the drift, of the footwall contact of the tin zone exposed in the Volney No. 1 and Volney No. 2 tunnels. Present exposures indicate an average width of 60 to 80 feet for this ore zone for a length of 450 feet. The character and nature of the occurrence in this section of the deposit are comparable to those in the Rough & Ready section. Insufficient development work and lack of sampling make a more detailed estimate of ore reserves impossible. It is probable that a development program connecting the Rough & Ready hanging-wall ore zone with the Volney would develop some 2,000 tons of ore per foot of depth for this section. Average values of 7.5 pounds per ton would probably be conservative. The bottom of the Tantalum Hill shaft is very nearly the level of the Rough & Ready tunnel level.

He estimates 100,000 tons of "possible" ore reserves for the Volney lode from the 60-foot level to the surface over a width of 60 feet and a length of 450 feet. At 7.5 pounds per ton, this block would contain 750,000 pounds of tin. The writer cannot check the expected tonnage or grade from the available data; the widths over which appreciable quantities of tin are found in No. 2 tunnel are 57 feet and in No. 1 tunnel, 9 feet.

As stated, the two crosscuts are 450 feet apart; the drift on the 60-foot level on the contact is 60 feet long beginning 80 feet horizontally from Volney No. 1 tunnel. Furthermore, the 60-foot drift has not been sampled, although some cassiterite was noted in place by the writer.

Possibilities of Future Production. - The samples taken by Thomas indicate that the dike contains tin, and although the two tunnels are too far apart to permit assuming that the intervening ground contains tin of a minable grade the showings are sufficient to warrant further development work, should the price of tin be high enough.

The Volney would be mined at the same time as the Rough & Ready, and the ore would be concentrated in the same mill. If production were contemplated from the Volney the first step would be to check Thomas' sampling. Efforts should then be directed toward proving up the mineralization between the two tunnels. Trenches should be dug at the surface and about three crosscuts run into the dike from the hanging-wall contact with the schist; each would be continued until the tin played out.

The cost of the trenches would be about $1 per cubic yard and of the crosscuts, $10 per foot. As the pegmatite was broken and cleaned up every tenth shovelful could be cast aside for a sample.

The cost of taking the sample is included in the unit estimates of the cost of the development work. Caring for and assaying a sample would cost about $5. The cost per sample of concentration would be about $12.50.

Giant Fraction

The Giant Fraction adjoins the Giant on the north and east. A 15-foot dike, which is probably an offshoot from the Giant stock, outcrops along the top of the ridge. (See fig. 11.) An open-cut has been run and two shallow shafts have been sunk on the dike. Several specimens on the dump of the cut contained crystals of cassiterite up to 1/2 by 1 inch in size. A narrow streak of pegmatite in the cut would assay 10 or 12 pounds per ton in tin.

The shafts and cuts did not open up any showings of interest, but if the price of tin were sufficient to encourage further development on the nearby Rough & Ready deposit it might be justifiable to sink on the streak of tin-bearing pegmatite in the cut on the Giant Fraction with the hope that it would lead to a body of tin-bearing material large and rich enough to mine.

Union

The Union claim adjoins the Giant Fraction on the north. A dike of pegmatite outcrops at the south end of the claim. A shaft about 50 feet deep was sunk on the dike in the early days of the district. Cassiterite crystals were found in the pegmatite on the dump; there were no indications of tin elsewhere on the dike.

The shaft is caved, but apparently the mineral showing on which it was started petered out. Cleaning the shaft and sampling any tin-bearing pegmatite in place might be justified if the price of tin were unusually high. The cost of cleaning the shaft would be about $200.

Daisy

The settlement and post office of Tinton are on the Daisy claim. A body of pegmatite about 150 feet wide and 300 feet long underlies the post office and recreation hall.

A few grains or crystals of cassiterite were found on the dump of a long cut below the hall; it is estimated that the pegmatite contains up to 1 pound of cassiterite per ton. A 90-foot shaft at the gas pump, a short distance from this intrusion of porphyry, is reported to have been sunk on a small outcrop of pegmatite containing some tin. The shaft is caved, and the dump was removed in grading for building sites.

Hamburg

The Hamburg adjoins the Giant and Giant Fraction on the east. A short dike in schist outcrops or is exposed by workings about the middle of the claim. It strikes N. 30° E., dips 60°, and is 7 feet wide and about 50 feet long. A 20-foot shaft has been sunk half in the dike and half in schist. A few small grains of cassiterite were found in pegmatite on the dump, but no cassiterite was found in place. A shaft a short distance to the south is in porphyry. The tin showing is insufficient to justify further work.

Bath

The Bath claim adjoins the southeast corner of the Daisy. A dike has been opened by a series of cuts along the trail between Tinton and "Tent Town." The dike strikes northerly and southerly and dips 50° to the west; it is about 100 feet long and 15 feet thick. A 1/4-inch crystal of cassiteri was found in the dump of one cut; doubtless a longer search would reveal othe specimens containing tin. No tin was noted in place.

The workings comprise a cut with a 6- by 30- by 10-foot face, a cut with a 6- by 20- by 6-foot face, and a cut 6 by 25 by 8 feet deep.

Spearfish

The Spearfish claim is near the southeast corner of the tin zone; it is about 3,000 feet southeasterly from the Tinton post office.

A dike about 225 feet long and 5 to 15 feet wide that strikes N. 20° E. and dips 45° to 55° to the west has been developed on the east side of Bear Creek on the claim.

The principal workings consist of a large open-cut (not measured), a cut 60 feet long from which a 400-foot adit has been run, and a 45-foot shaft. The cuts are on the dike; the adit was started in the dike but soon cut through it and was extended into the country rock. A 45-foot shaft that was started in overburden 125 feet southwest from the portal of the adit pparently cut the same dike; the top of the dump is pegmatite. The cuts and shaft are old work. The adit was run by the Black Hills Tin Co. in 1934.

The adit started at a narrow lens a few feet long, which apparently ould be tin ore at present prices if it occurs in minable quantity. At nother place in the cut, now used as a powder magazine, about 5 feet of aterial contained scattered crystals of cassiterite. One hand specimen of few pounds next to the schist contained 4 or 5 percent tin. A few solated crystals were noted elsewhere in the dike where it was exposed.

According to a report by H. N. Spicer dated December 15, 1910, five ertical core-drill holes were drilled beginning 50 feet north of the open-ut on Bear Creek; one was drilled to a depth of 354 feet. Spicer did not ave the results of the drilling but stated that it was reported that 29 eet of vein matter was found; if corrections were made for dip, the width f the dike would be 22 feet. He also stated that an assay of 1.5 percent uite tin was reported. John Bland, who has the Spicer report, states that e found cores from the diamond drilling on the ground, some of which contained tin. The country rock penetrated was schist; the holes were in the anging wall.

A fairly wide dike outcrops for a short distance near the south end of e claim. A search revealed a few small crystals of cassiterite.

The showing of tin at the portal of the adit probably is the most portant on any dike aside from the Rough & Ready deposit. Only a few uare feet of the material exposed is of high enough grade to be mined at a rmal price for tin. Moreover, there is no assurance that this showing uld extend any distance beyond the face. With an unusually high price for n, however, development of the deposit might be justified. The first step uld be to sample all faces containing tin and follow the best exposure derground. The cost of sampling with a 2- by 6-inch groove would be $6.50 r sample. Drifting would cost about $12 per foot. A portable compressor uld be brought to the ground. Sinking a prospect shaft up to 50 feet deep uld cost $40 per foot and a working shaft to 100 feet, $75 per foot.

Centaur and Iron

The Centaur and Iron have common end lines. The Iron adjoins the Spear-h on the south. A cut and a caved 61-foot adit at the west end of the taur are apparently on the same dike that was opened in a caved shaft on Van, about 300 feet easterly. A cut 50 feet long and 30 feet wide over the end line of the Iron claim is also on the same dike. The dike in the cut is about 20 feet wide and dips 55° to the southwest. Fine specks of cassiterite occur in albite in the dike. Four samples taken by A. E. Thomas from the dike in the drift (24 to 61 feet in) averaged 1.6 pounds of tin to the ton; samples taken over a width of 15 feet on the Iron dike averaged 3.5 pounds to the ton.

Van

The Van claim adjoins the Centaur on the west. A shaft has been sunk on a dike to a depth of 23 feet and a 12-foot drift run from the bottom as shown by the patent plat. The workings are caved, and the dike does not outcrop. About 1 piece in 20 pieces of dike material on the dump contains specks of tin.

Yosemite

The Yosemite claim is near the south end of the tin zone; it adjoins the Van on the west. The Yosemite dike is 15 feet wide, strikes N. 15° W., and dips 45° to the west; it is exposed for a total of more than 100 feet. Most of the cassiterite in the dike is associated with quartz near mica seams; the dike also contains albite in which are found some fine specks of cassiterite. The dike outside of No. 2 cut was nearly barren of tin. A little tantalite is associated with the cassiterite.

The workings consist of No. 1 cut with a 6- by 20- by 12-foot face across the dike, No. 2 cut with a 7- by 40- by 15-foot face across the dike, and No. 3 cut with a 10- by 10- by 10-foot face along the strike. No. 2 cut is 20 feet west of No. 1, and No. 3 is 50 feet beyond No. 2.

A parallel lens to the north is opened by a small cut. It is about 5 feet wide where exposed.

A sample taken by A. E. Thomas across 7 1/2 feet of the footwall of the dike in No. 2 cut contained 10.1 pounds of tin per ton; a sample across 6 feet of the hanging wall contained 2.5 pounds per ton. The average for the 13.5 feet was 5.2 pounds per ton. A sample taken recently in the same cut over an unknown width by Dr. A. T. Roos showed 3.6 pounds of tin per ton.

If the price of tin were sufficient a shoot large enough to mine might be developed at No. 2 cut. The first step would be to check the sampling and explore the footwall section of the dike both ways from the face of the cut. If the preliminary work were encouraging, the next step would be to sink on the best showing.

The cost of sampling in the open-cut would be about $8.25 per sample.

Open-cut work by hand would cost about $1 per cubic yard and sinking a 5- by 7-foot project shaft up to 50 feet, $40 per foot.

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Modoc Chief

The Modoc Chief is about 1,700 feet southeasterly from the Tinton post office. A dike outcrops for 150 feet along the east side line and extends into the Crow Dog, the adjoining claim on the east. The dike is 3 to 4 feet wide and strikes northerly and southerly. A few cassiterite crystals were found in the outcrop.

About 400 feet to the west along the side line is a belt striking northerly and southerly 40 feet wide and about 150 feet long with several narrow dikes or lens of pegmatite. The overburden contains considerable pegmatite. A 7- by 8- by 12-foot shaft, a 5- by 7- by 31-foot shaft, and a 5- by 8- by 20-foot cut were sunk on pegmatite bodies. It is estimated that the pegmatite in the workings assays 2 or 3 pounds of tin per ton.

Aurora Fractional

The Aurora Fractional claim is about 1,000 feet east of the Tinton post office. It adjoins a fraction claim on the north end line of the Modoc Chief.

A short dike 3 to 4 feet wide outcrops on the south side of Hungry Creek. The dike strikes north and south and dips 41° to the west. The pegmatite is estimated to contain 1 or 2 pounds of tin per ton.

Cornelia

The Cornelia adjoins the Aurora Fractional on the east. A 6-foot dike that strikes northerly and southerly and dips 40° to the west crosses Hungry ulch about the middle of the claim. The country rock is a siliceous schist. he pegmatite contains a relatively large proportion of feldspar. A 30-foot ut and incline have been sunk on the dike on the south side of the gulch. he pegmatite in sight on the dump was estimated to contain 5 pounds of tin er ton. A sample taken across the vein in place in the cut assayed 0.08 ercent or 1.6 pounds of tin per ton.

The same dike is disclosed in two cuts across the gulch. Its width anges from 1 1/2 to 6 feet and at the northern exposure is 3 feet. After a -minute search by four men a few pieces of pegmatite with one or more grains f cassiterite were found.

A small part of the dike may contain 5 pounds of tin per ton.

Crest

The Crest adjoins the Cornelia on the north. A 30-foot timbered shaft, 20-foot cut, and a 30-foot cut have been sunk on a 1-foot dike on the rest near the middle of the west side. The dike strikes N. 10° W. and dips 7° to the west, but as far as could be seen it contained no tin.

Tintic and Swansea No. 3 & 4

The Tintic is about 2,000 feet northeasterly from the Tinton post office. A 130-foot caved adit starts on the Tintic and connects with a caved 40-foot shaft on the Swansea No. 3 & 4. The workings develop a dike 2 to 4 feet wide. The pegmatite on the dump is estimated to contain 4 to 5 pounds of tin to the ton. The dike dips 50° to the west; the country rock is hornblende schist.

Tintic No. 1

The Tintic No. 1 adjoins the Tintic on the west. A 1- to 2-foot dike has been opened by a cut on the north end of the Tintic No. 1. The dump is estimated to contain between 8 and 10 pounds of tin per ton.

Salvader

The Salvader is about 1,500 feet northerly from the Tinton post office. A short dike up to 4 feet wide outcrops on the claim. It strikes N. 40° W. and dips 60° E. The country rock is schist. The dike appears to pinch out on the east side of the gulch, where it is developed by an adit. The pegmatite carries some coarse crystals of cassiterite; the tin content is estimated at 5 or 6 pounds to the ton. At the narrow end of the dike a few tons in place contain 2 or 3 percent tin.

Yeddo No. 1

The Yeddo No. 1 is about 500 feet east of the Tinton post office; it adjoins the Salvader on the north and the Aurora Fractional on the west.

A 6- by 6- by 10-foot cut near the center of the Yeddo No. 1 is on a narrow dike that in places contains 1 to 2 pounds of tin to the ton. A second dike 8 by 10 feet wide outcrops on the north end of the claim. The pegmatite on the dump of a 5- by 70- by 6-foot face cut is estimated to contain 2 to 3 pounds of tin per ton; no tin was noted in place.

Yeddo

The Yeddo adjoins the Daisy on the east and the Yeddo No. 1 on the west. An intrusion of pegmatite forms a mound 75 feet wide by 300 feet long near the eastern side line (see fig. 11) of the Yeddo. The surface slopes with the dip of the dike; the minimum thickness of the dike is about 15 feet. A 15- or 20-foot caved shaft at the end of a cut has been sunk on the dike. Most of the dike as exposed is barren, but samples indicate that 2 or 3 pounds per ton could be obtained in places. One small crystal of columbite was noted in the dump of a small cut on the top outcrop.

Manchester

The Manchester is one of the northern lode claims belonging to the company. A 4- by 7- by 15-foot cut has been made on a 12-foot pegmatite dike; the dike strikes N. 20° to 40° W. and dips 48° to the east. Pieces of pegmatite on the dump contain crystals of cassiterite, but no tin was noted in place.

Jersey No. 1

The Jersey No. 1 is one of the two most southerly claims belonging to the Black Hills Tin Co.; it is about 7,500 feet southerly from the Tinton post office. It contains a body of pegmatite about 25 feet wide by 75 feet long in porphyry. A 25- and a 10-foot shaft have been sunk in the pegmatite. The strike of the pegmatite is northerly and southerly and the dip about 55°. A search revealed a few specks of cassiterite.

Lafayette No. 2

The Lafayette No. 2 claim is at the Wyoming line on the highway from Tinton to Savoy, about 4,500 feet southwesterly from the Tinton post office.

A pegmatite dike up to 1 foot in width that contained cassiterite and tantalite was opened up by some shallow cuts in 1928 on the east side of the road. The length exposed was about 25 feet. The dike is in porphyry. The pegmatite consists mostly of feldspar with minor quantities of quartz and mica. The cassiterite and tantalite occur as large crystals; judging by the material in sight, the pegmatite should contain 10 or 15 pounds of the two minerals per ton.

On the opposite side of the road a second dike, or a continuation of the first, has been opened in a 6- by 8- by 20-foot cut. The dike here is 3 feet wide, dips 60° to the west, and strikes northerly and southerly; it is also in porphyry. The pegmatite was estimated to contain 2 or 3 pounds of tin per ton.

A high enough price for tin might justify sinking on this dike in the ope that the dike would widen out and the grade increase. The cost of sinking a prospect shaft up to a depth of 50 feet would be about $40 per foot.

Connors Tin Production Co.

Boston Group

The Connors Tin Production Co. has 32 claims; the middle 14 claims, alled the Boston group, adjoin the property of the Black Hills Tin Co. on he north. (See fig. 11.) George Connors of Tinton and Milton Connors of eadwood are the principal owners. The Boston and Commercial claims of the group were visited July 20 in company with A, I. Johnson, Earl C. Schultz, . C. Lincoln, Geo. E. Flavin, and Paul T. Allsman.

Boston Claim. - As far is is known, this and the adjoining Commerical laim are at the northern end of the tin belt.

The Boston dike is approximately 4 1/2 feet wide, strikes about N. 5° W., nd dips 35° E.; it cuts the schist formation. The dike outcrops for about 00 feet on the surface then disappears at either end under overburden. It as been developed by a 90-foot incline shaft and two cuts; the work was done n 1909. The water stands 15 feet from the collar in the shaft. The pegmatite in the dump of the shaft is estimated to contain about 5 pounds of tin to the ton. A few crystals of cassiterite were noted in place in the cuts.

A 2 1/2-foot dike parallel in strike but steeper in dip occurs about 70 feet to the south. Cassiterite was noted in two specimens of pegmatite from this dike.

Commercial Claim. - A 3-foot dike dips about 20° W. on the Commercial claim; the country rock is schist. A 6- by 24-foot cut with a 9-foot face has been run on the dike. The dump is estimated to contain 2 to 3 pounds of tin per ton. Cassiterite was noted in one spot in the face.

Possibilities of Future Production. - The 90-foot shaft on the Boston apparently was sunk on the best showing of the group. If further development work were contemplated, the first step would be to unwater this shaft and sample the dike down both sides. If results of the sampling were encouraging, drifting would be the next step. As the dike is only 4 1/2 feet wide and as its known length is only 100 feet, a large tonnage could not be expected.

The shaft could be unwatered and repaired for about $750, and 10 groove samples could be taken and assayed for about $150. One hundred feet of drifting from the bottom of the shaft would cost about $1,500.

Bear Gulch Mining Co.

An 8-foot tin-bearing pegmatite dike that strikes northwesterly and southeasterly and dips 37° W. was shown the writer by A. J. Johnston. Johnston stated that the claim was on a patented claim belonging to the Bear Gulch Mining & Milling Co. As no corners were found on the ground the claim could not be identified. As far as could be ascertained without a survey, it is in the approximate position shown as Elizabeth No. 8 on figure 11. This dike is in the northeast corner of the Tinton tin zone. The country rock is schist.

A 150- to 200-foot adit has been run on the vein; the drift connects with a 110-foot incline shaft sunk on the dike from above. The adit dump comprises 150 to 200 tons of pegmatite that contains 4 or 5 pounds of tin per ton. The workings are caved, and most of the dike is covered with overburden.

Possibilities of Future Production

The dike, as indicated by the pegmatite on the dump, is too low in tin to warrant further work unless the price of tin soars. If further work were contemplated, the first step would be to clean out and sample the adit and the shaft. The repair work would cost up to $2,500, depending upon how badly the workings are caved.

The cost of taking 30 samples at 5-foot intervals in the adit at about $8.25 and 22 in the shaft at about $15 would be about $575.

Dakota Tin & Gold Co.

In July 1938 the Dakota Tin & Gold Co. was developing a dike on what was locally known as the John White claims, which comprised about 27 acres of unpatented ground between the holdings of the Black Hills Tin Co. and the group belonging to Mrs. George White. The property is near the southeast corner of the tin zone about 21 miles from the railroad. W. O. Filmore, Spearfish, S. Dak., was the promotor, president, and general manager of the company.

The dike is developed by 50 feet of drifting from a crosscut from a 50-foot shaft. The drift is also connected to the surface by a 178-foot crosscut adit. A three-compartment shaft timbered with 12- by 12-inch sets was being sunk to intersect the vein on the 150-foot level. When the mine was visited (July 26, 1938) the shaft had reached a depth of 110 feet. A crew of 13 men, including manager, cook, surface men and men cutting and sawing timber for the sets, were making a progress of 5 feet per week.

The dike strikes nearly north and south and dips 45° W. As shown by open-cuts the dike was 5 feet wide at the surface; where penetrated by the crosscut it is 8 1/2 feet wide, in the face of the left drift 3 feet, and in the face of the right drift 5 feet.

The dike contains some tin. A few scattered crystals were noted at the surface. Two small lenses, each about 1 by 2 1/2 feet, near where the vein is cut by the crosscut contain about 10 pounds of tin per ton. It is estimated that the vein on the 50-foot level would average 3 or 4 pounds of tin per ton. Parts of the dike contain about 50 percent feldspar in fairly coarse segregation. The only production of tin from the claim has been a small quantity of concentrates from placer diggings on Potato Creek.

Mrs. George White Group

Golden Star

The group of 14 claims belonging to Mrs. George White, of Tinton, is in he southeast section of the tin ore zone. A 1- to 1 1/2-foot tin-bearing egmatite dike in schist occurs on the Golden Star claim of the group near otato Creek. This is the southwestern exposure of tin in the Tinton area.

A 75-foot caved adit in porphyry apparently was driven to cut the dike t depth, but no pegmatite is evident on the dump. The tin crystals in the ike are small and scattered; it is estimated it contains less than 1 pound f tin to the ton.

It was stated that tin-bearing dikes occur on other claims of the group, ut a search revealed none. The writer was accompanied over the ground by eorge White of Tinton; he, however, was not familiar with the mineral howings. The claims were left to Mrs. White by a former husband who located nd patented the ground.

A. J. Johnston Groups

A. J. Johnston alone and with others has several groups of claims under location on the west and north of the holdings of the Black Hills Tin Co. Figure 11 shows one of these, the Johnston and Stromsnes group. Most of the claims are held for prospective gold values.

Johnston lives on a claim of the group at the northwest corner of the Black Hills Tin Co. holdings called the Anna Fraction No. 2. The claims were visited July 25, 1938, in company with Johnston.

Anna No. 2 Fraction

The Anna No. 2 Fraction is about 6,000 feet northwestward from the Tinton post office, mostly in Wyoming. The country rock is schist. A pegmatite dike 50 feet wide is exposed for a length of about 300 feet on the claim. The dike strikes northwesterly and dips W. A cut with a 6- by 10- by 10-foot face has been run on the dike near the southern end; another cut 6 by 8 by 20 feet long has been made to the north on the dike. In the face of the first cut one 1-inch crystal of cassiterite surrounded by quartz was in place; a few specks of cassiterite were found elsewhere in the cuts. No tin was noted in the dike except in the cuts. Johnston states that he has also found tantalum in the pegmatite.

Anna No. 1 Fraction

The Anna No. 1 Fraction adjoins the Anna No. 2. A pegmatite dike on this claim strikes parallel to the one on the Anna No. 2 Fraction; it is 20 to 30 feet wide. Johnston states that he has found cassiterite and tantalite on the claim, but none could be found during the writer's visit.

Louis No. 2

The Louie No. 2 adjoins the Anna No. 1 Fraction. A dike about 50 feet wide and 250 feet long occurs on the claim. Johnston states that some tin was found in excavating a cut and 20-foot shaft in the dike. None is now in sight, either in place or on the dump.

Scotland Group

The Scotland comprises a group of unpatented claims along the State line at the northern limit of figure 11. In 1938 the claims had been relocated under different names by Johnston and others.

An old shaft at a cabin on the State line at the common corner of secs. 16 and 21, T. 51 N., R. 50 W., Wyoming meridian, is on a 6- or 8-foot pegmatite dike. Johnston states that tin was found in sinking the shaft, but none was evident in the dump.

About 600 feet south and 400 feet west of the section corner, a 100-foot ledge of granite outcrops. Johnston states that tin has been found in the granite, but a diligent search along the outcrop failed to disclose any cassiterite.

Ernest Johnson Placer

In July 1938 Ernest Johnson was placer mining alone by hand on Bear reek about 2 miles by trail from Tinton.

About 3 feet of ground at the rim of old placer diggings was being orked. The top 1 foot of soil was cast aside, and the lower 2 feet were hoveled into a sluice box. The bed rock was rough. Between 5 and 6 cubic ards was handled daily; the box was cleaned up every 3 hours.

In 2 1/2 months of work he had recovered about 1 1/2 ounces of gold and 50 pounds of tin concentrate containing some tantalite. All tin in the round is not recovered as work is continued after the riffles are filled ith concentrate.

SUMMARY

About 14,330 tons of tin ore and 121,000 pounds of tin, have been proiced from the Tinton area.

About 143,000 short tons of ore assaying 7.5 pounds of tin per ton, about 500 long tons of metallic tin), has been partly blocked out on the ugh & Ready claim of the Black Hills Tin Co.; an additional 50 long tons tin is contained in ore partly blocked out on other claims in the district. it is assumed that the ore zones on the Rough & Ready continue downward, d of the same grade, each 100-foot vertical interval would contain 340 ng tons of metallic tin. If the block that contains 4.1 pounds per ton is cluded, the total tin content per 100 feet would be 1,102 tons. The parent average daily consumption of new tin in the United States in 1937 s 237 long tons.37/

The partly blocked out ore on the Rough & Ready claim would run the 0-ton mill on the ground for about 3 years. For profitable operation, wever, the price of tin would have to be higher than in normal times. A all production of tin also could be expected from other claims in the area the price of tin were high enough.

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